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JOURNAL

OF THE

AMERICAN FOUNDRYMEN'S

ASSOCIATION.

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PROCEEDINGS OF THE PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The sixty-third meeting of this Association was held on Wednesday evening, December 2d, at the Manufacturers' Club, in Philadelphia. The newly elected president, P. D. Wanner, of the Reading Foundry Co., Ltd., presided. After calling the meeting to order, Mr. Wanner expressed his appreciation of the honor conferred upon him at the last meeting in the following address:

Gentlemen—Permit me to thank you for the honor received at your hands. I shall regard it a duty, as well as a pleasure, to advance the interests of this Association, as its president, as far as it may be within my power. It has been a source of much gratification and benefit. Our meetings have been pleasant and instructive, and there is no reason why they should not be even more so in the future, especially when we come to reflect that we were organized during a declining market and that we prospered while going through a prolonged and severe panic which bore hard upon all, stranded some, and often dismayed others. Among results accomplished we can point with pride to the Western Foundrymen's Association, the Eastern, the Texas, and

the National. Now that election is over and a definite policy settled upon, it is in order to predict great possibilities in store for us in the near future. I believe that this century will close in the midst of the largest expansion of business and the greatest happiness of the people ever known to American history.

Trusting that we may all realize the hopes I have expressed, I thank you for your courtesy.

Secretary Howard Evans: Those of you who attended the last meeting will remember being shown a piece of slag from Abendroth & Root's cupola. It was very porous and light in color and was sent to us for the purpose of ascertaining what it was composed of, and to know what caused its peculiar formation. Mr. E. K. Landis, 208 South 4th street, this city, very kindly volunteered to make an analysis. He reports the analysis as follows:

Silica	50.10
Oxide of iron and alumina	20.90
Lime	29.396

The oxygen ratio of acid to bases is 2 : 3. This makes it a sesquisilicate.

The report of the Executive Committee was then read as follows:

Your committee would report that they have received a number of letters from different parts of the United States, every one of which acknowledges there is a better feeling and an improvement in the foundry business showing a wholesome increase. There is no boom and it is well there is not, as it would surely be accompanied with a drawback later on. We might cite a dozen different foundries in this immediate neighborhood who are running full time and have sufficient orders to carry them through the greater portion of the winter, while others have found no improvement whatever. The fact of it is, too many false hopes were raised by unwise and in many cases untrue press statements relative to the amount of business that would be started at once, and now these facts do not fulfill the expectations. Some people

are inclined to take too gloomy view of affairs and lose all reasonable hope of coming improvement. Those who look at the situation in this light are merely flying to another extreme. People must remember that it takes time to affect a general recovery of business and put it on a basis of general prosperity. The very worst thing that could happen to the country at this time would be to start a wild boom, create fictitious values and reach a heighth from which trade would soon have to tumble. A few days of fancied prosperity would be followed by a period of depression which would be most disheartening to the business interests of the country. A fair look over the entire situation will show that considerable progress is being made. All lines are prepared for a largely increased trade which will come to stay. Everything indicates that we are now on the up grade, but we must not expect too much at once. "It is an ill wind that blows nobody good." The late cold snap that has extended all over the country is a good thing for the coal operators, but it makes extra work for the man who gathers the ashes. As far as we can see at this time and to sum up the whole question, we are slowly recovering from the depressed condition of trade and finance of the past three or four years.

The above is respectfully submitted.

The secretary then read several letters which he had received in reply to a request, embodied in the call for this meeting, for expressions of opinion from those unable to attend, as to the prospects for an improvement in business, and for reports as to the influx of orders and settlements of accounts since the election.

The general tone of the replies indicated that a better feeling prevailed, resulting in an increased demand, backed up by an easier money market.

The Chairman: I should like to call attention to the name of our Association. In view of the fact that we have other associations, had we not better assume and take another name? Since foundrymen of Philadelphia are particularly interested in

this matter, should not this be called the Philadelphia Foundrymen's Association? I am simply suggesting this.

Mr. Evans: At the time this Association was formed no other association of a like nature existed, therefore it was decided that it should be national in character. We have on our roll of membership representative founders from all over the country.

The Chairman: I did not make my suggestion with the idea that any change in the membership should be made, but simply that some distinction should be embodied in the name.

Mr. Devlin: I do not think the name places us at any disadvantage. It is prominent enough to take in members from any part of the country. I think the question, with others, might be submitted to a committee. It would be well to have a foundrymen's association in character as well as in name. As far as the few foundrymen of Philadelphia who attend our meetings are concerned, it is not very local in character. The members who attend best come from a distance. Mr. Devlin then went on to speak of the proceedings at several of the meetings of the Association in which politics were entered upon, and condemned the mixing of politics with business at the meetings of the Association. He said: "I am strongly opposed, and have been from the beginning, to the mixing of politics with our business. There are men of all opinions among us, and therefore political discussions should be avoided. Let us bring the Association meetings up to what they should be—foundrymen's meetings.

The Chairman: The business men of old could not help themselves. Business has been so closely allied with politics. Politics have been either making or ruining business.

A paper by Thomas D. West on "The Utility of the Test Bar and Standard Systems for Comparative Tests" was then read by James S. Stirling, as follows:

"Utility of the Test Bar and Standard Systems for Comparative Tests."

Many lose sight of the real utility of test bars. They entertain the idea that they will give the actual strength, contraction or chill of single castings. The only way to get these qualities is

by making test bars of the same thickness and form, if possible, as those of the casting for which comparisons were to be drawn. In reality this would mean making two castings and breaking one to get the strength, etc., of the other. The true utility of the test bar is simply comparative, to define differences that may exist in mixtures of the various "grades" of iron, or, in other words, all that the test bar will do is to denote the strength, etc., of the iron which is poured into the mold; and what the shape and size of that mold would do to distort the physical qualities of the iron from agreeing with what the test bars have recorded, is largely left for experience to guess at or comparative tests of broken castings to define.

Where there are many duplicates, as in the manufacture of car wheels, pipes, etc., we can, by breaking a few castings and test bars that have been cast out of the same ladles of iron, obtain a very fair base as a standard for future comparisons of what may be expected in the castings themselves from test bars cast from future mixtures. This is not saying that single castings made of the same pattern, cast at different times, could not have any knowledge imparted of their strength, etc., by reason of using a proper test bar, cast with the same ladle of iron. In most all such cases, the test bar is of much value, and the best means that can be employed in enabling the builder and purchaser of castings to judge of what either may expect the actual use of his castings to demonstrate. If a casting stands severe usage and the builder or buyer has a record of test bars that was poured of the same iron with the casting, he generally can rest fairly assured that if, at any other time he should get another casting made, with a test bar that would show a similar strength, he would have a casting that would be fairly equal in strength, etc., to any previously made. And again, the use of these can often prove protection to builders that have machines broken by claimants for unjust damages, as for instance, in the case of punch and shear castings, which are often broken by reason of carelessness on the part of workmen or attempts being made by the proprietors to utilize a machine above the strains guaranteed.

The value of a test bar has never been appreciated in its right sphere, to the degree it should be, but the writer believes the time is not far distant when the machine shop will be as interested in the test bar as many engineers and founders are to-day; and when this time does come, the utility of a standard system will be strongly forced upon us and no doubt an effort will be made to establish and recognize standards for physical tests. How are we going to be able to make intelligent comparisons with our own records or those of others, where we find bars as small as one-half inch square to two inch square being used, and some of rectangular form, and again it can be said, in all kinds of lengths, from a foot up to four feet long, so that we practically find hardly two founders using the same form or length of a bar, or builders and engineers exacting the same character tests?

Some will say that the difference in both the length and area of such a variety of bars could be computed to strength per square inch, in making comparisons. It can be shown that there is about as much difference to be found in formulas for computing such variations, as is found above in test bars, and also that so eminent and able an authority as Prof. C. H. Benjamin, of the Case School of Applied Science, has shown that present recognized formulas are wholly unsuited and incorrect for figuring the strength of cast beams, etc.

The prevailing practice of recording tests to-day, may in some cases be accepted as an approximation in so far as it relates to a firm's own practice in making comparisons for mixture, with permanent hands, but should a firm desire to bring in a new manager or tester, who has been guided in rulings or records obtained from other shop practice or systems, his past experience will prove of very little value to him; hence the firm must lose in many ways before the new man is enabled to be rightly guided by information which he can deduct from his new system. Then again, a manager or tester in making any changes, is also a loser and is subjected to the same inconveniences as just mentioned. This shows us that both sides can be heavy losers, saying nothing as to what is lost by their not being able to make intelligent comparisons with

the outside foundry and engineering world, or with blast furnaces from which large quantities of pig metal must and should be intelligently purchased. Present practice shuts us up like a clam, and makes us dead to all the benefits which a standard of physical tests could insure. Progression demands something broader and of more correct utility than the present practice insures.

In reviewing tests recorded of test bars or castings in our engineering text books of the past, we find the practical utility of the same to be largely lost for the reason that there is no base presented upon which to formulate mixtures, to duplicate fairly the "grade" of the iron comprising the casting or test bar whose strength, etc., has been recorded. If for each test of all such castings or test bars we had a standard system, we could then by referring to the tests of any mixtures in our own practice, which had recorded similar physical qualities in a test bar, be at once in the most favorable position attainable to produce a similar casting, having like physical qualities. Some might suggest the chemical test of the castings being recorded in order to give a base for making comparisons and duplication of like castings. This would work admirably in most all cases, but of the two methods the physical test is often more economical and practical for adoption by many founders, for the reason that there are some who can afford to conduct physical tests, but who cannot maintain a laboratory with its chemist, or engage outsiders. Even where founders are equipped with laboratories, the physical tests are necessary as a "hand-maid," to tell what is being achieved, and still further argue for the advisability of a standard system of physical tests.

If there were no difference in the "grade" of an iron as daily produced by founders, then any record of the strength, etc., of mixtures would be alike and we would not require any physical tests, but when we consider mixtures of iron can be made ranging all the way from 600 to 4,000 pounds, with an equal inch area bars 12" between supports, it plainly illustrates the benefits to be derived by accompanying a casting with tests obtained from the same ladle of iron by means of suitable test bars, whether the strength is obtained by means of transverse or tensile tests to make comparisons.

Because the $1\frac{1}{8}''$ round bar is large enough to not have its carbon severely distorted to make tests erratic by the chilling influence of a green sand mold, and also because it is not so large, but that the strongest "grades" can be tested for comparison with weak "grades" on low priced testing machines, are the main reasons why the writer contends for the universal adoption of the $1\frac{1}{8}''$ round bar as one standard for making comparative tests. Having shown in previous papers that the $1\frac{1}{8}''$ round bar is fitted to record degrees in the strength of cast iron to largely agree in a comparative way with the commercial value attached to the strengths of the various mixtures ranging from stove plate up through light machinery, heavy machinery, car wheel, chill roll and gun metal, the writer would now refer to other two sizes, $1\frac{5}{8}''$ and 1 15-16" diameter as being also well fitted for recognition as standard bars. These two latter sizes of bars are best utilized by founders who may make mixtures containing less than 1.00 in silicon and above .04 in sulphur. For those above 1.00 in silicon and below .07 in sulphur, the $1\frac{1}{8}''$ diameter bar will be found to record very good comparisons in degrees of strength.

It is to be understood that while either size of the above three proposed standard bars would not err much in recording true degrees in the strength, deflection and contraction of the various "grades," where comparisons are to be made in any one "grade" or in all of them, the same size bar must be used. One size bar cannot be used for one per cent silicon iron and then dropped and another taken up to test percentages above or below this. Whatever size of a bar the testers use, in making comparison through any range of work, they must stick to that one, and then, if they desire to make comparison with outside records that have been obtained with standard bars other than the one size they use, they would then be compelled to make tests with the same size of bars which have been used to obtain the outside test. Of course, if a firm desired, they could cast the three sizes of bars together, with the same ladle of iron, and thus always have at hand records by which they could make comparisons on a moment's notice, with any outside tests that had been obtained with either of the three standard sizes of bars mentioned herein.

The following tables, 1 to 7, display tests of the writer's proposed three sizes of standard bars accompanied with a chemical analysis of the various mixtures shown to still increase their value. A study of these tables, the writer believes, will sustain him in his advocacy of the $1\frac{1}{8}''$, $1\frac{5}{8}''$ and 1 15-16 round test bars as best fitted for and to maintain a standard of physical tests.

The tests presented are obtained from the actual mixtures used for pouring castings in the various specialties mentioned and, as seen, are arranged in the order of their strength. Double the amount of tests were made, but those shown illustrate the relation of the different areas in strength per square inch, as well as large quantities could, and make study an easy task to readily demonstrate their utility, as being all-sufficient for standard comparative tests.

The tests shown are all of solid bars cast on end, and they illustrate among other valuable features, the fact that the two and three-inch square area round bars record a greater strength per square inch than the one square inch area bars; and were it not for the fact that the round bars of two and three-inch square area require costly testing machines, they would be the best size for all to adopt as standards. Nevertheless this series of tests shows conclusively that no one should use a test bar smaller than of one square inch area with the expectation of making any fair comparisons of degrees in the strength, etc., of his irons. While the one square inch area round bar shown does not record the high strength for strong metals that the larger bars do, it is made very evident that they do record degrees of strength sufficiently well to be used for a comparative test by any that may desire to adopt it, a fact also demonstrated by a paper read by the writer before the Western Foundrymen's Association, October 24, 1894, and shown in the Iron Age and the Iron Trade Review of November 1, 1894.

The test bars shown in this chapter were cast during the month of May, 1896, and were kindly supplied by the foundries of the Lloyd-Booth Co., Youngstown, Ohio; Philadelphia Roll & Machine Co., and A. Whitney & Sons, both of Philadelphia, Pa., and the Chenango Machine Co., and Graff Stove Foundry Co., both of Sharon, Pa. The test of "Bessemer," Table 6, was cast by the writer.

Tables 1, 3, 4, 5 and 6 were tested by Prof. C. H. Benjamin at the Case School of Applied Science, and those of Table 2 by the Riehle Bros., of Philadelphia, Pa. The strength per square inch is obtained by dividing the actual breaking load by the area of the bar, at its point of fracture.

The chemical analyses seen in Table 7 were kindly furnished by Dickman & Mackenzie, of Chicago, and Dickman & Crowell, of Cleveland.

Aside from the attention which has been called by this paper to various points in the following tests, there are two factors which many will be at a loss to understand. The first is the break in the gradual increase of strength of the $1\frac{1}{8}''$ bars, which is displayed by test No. 7 being weaker than tests Nos. 4 and 10. This is due to the high sulphur in the iron when in this small body of $1\frac{1}{8}''$ diameter, causing the combined carbon to overreach its limit for gradually increasing the strength of the $1\frac{1}{8}''$ bars, as shown in tests Nos. 1, 4, 10, 13 and 16. The second factor is that shown by the low strength displayed by the "Bessemer" iron shown in Table 6. This is caused by reason of the low phosphorus necessary to make Bessemer iron. Had this metalloid been near the percentage shown in Table 4, the strength of the test bar No. 7 should have equaled somewhere that of No. 10.

Transverse Tests of Specialty Irons with One, Two and Three Square Inch Area Test Bars.

No. of test	Common rule. Diam of bar.	Micrometer	Breaking load	Area of bar	Strength per sq. in in lbs	Deflection
TABLE 1—CHILL ROLL IRON.						
1	1⅛"	1.140"	3,250	1.021	3,183	0.105
2	1⅝"	1.655"	9,500	2.151	4,417	0.090
3	1 15-16"	1.968"	15,250	3.042	5,013	0.085
TABLE 2—GUN CARRIAGE METAL.						
4	1⅛"	1.122"	2,780	.988	2,812	0.100
5	1⅝"	1.654"	9,250	2.174	4,254	0.110
6	1 15-16"	1.859"	11,820	2.714	4.355	0.100
TABLE 3—CAR WHEEL IRON.						
7	1⅛"	1.174"	2,200	1.082	2,033	0.053
8	1⅝"	1.690"	8,100	2.244	3,610	0.070
9	1 15-16"	2.008"	13,500	3.167	4,263	0.072
TABLE 4—HEAVY MACHINERY IRON.						
10	1⅛"	1.187"	2,800	1.1066	2,530	0.092
11	1⅝"	1.705"	7,100	2.282	3,111	0.072
12	1 15-16"	2.001"	11,900	3.143	3,786	0.079
TABLE 5—STOVE PLATE IRON.						
13	1⅛"	1.182"	2,500	1.097	2,288	0.117
14	1⅝"	1.745"	6,050	2.391	2,530	0.078
15	1 15-16"	2.047"	9,900	3.288	3,011	0.081
TABLE 6—BESSEMER IRON.						
16	1⅛"	1.175"	2,150	1.084	1,983	0.100
17	1⅝"	1.698"	5,500	2.263	2,430	0.100
18	1 15-16"	1.991"	8,900	3.112	2,860	0.085

TABLE 7—CHEMICAL ANALYSIS.

Specialty.	Silicon.	Sulphur.	Mang.	Phos.	Comb. Carbon.	Graph. Carbon.	Total.
Chill Roll	.84	.071	.285	.547	.61	2.45	3.06
Gun Metal	.73	.059	.408	.453	.76	2.47	3.23
Car Wheel	.78	.132	.306	.364	1.07	2.36	3.43
Gen'l Machinery	1.30	.053	.224	.433	.58	3.31	3.89
Stove Plate	2.47	.094	.265	.508	.19	4.00	4.19
Bessemer Iron	1.52	.059	.326	.083	.49	3.73	4.22

Mr. Stirling: Can any one tell me what should be the comparative or relative strength of a test bar 4 ft. 6 in. between supports compared with one 12 in. between supports. Is there a regular ratio for that?

Mr. Whitney: It can be figured out with the Johnson formula. As far as the length goes that is taken into consideration perfectly.

Mr. Stirling: The reason I ask is that we have in use a Fairbanks testing machine only adapted to testing bars 12 in. long. We are making some castings now on which the specifications call for test bars 4 ft. 6 in. long. We should prefer to make them 12 in. long and make comparative tests.

Mr. Whitney. If you use the short bar you would have to allow a difference on account of the extra difficulties incident to the use of the long bar—partly on account of the bending.

Mr. Wiggin: The strength would vary according to the length. You would expect a bar 1 ft. long to stand four and one-half times as much as one 4 ft. 6 in., providing it was of the same area.

Mr. Whitney: You would have to take in a little more than the area. Johnson's formula takes in every factor.

Mr. Wiggin: There may be some other reasons, but what I have stated is the theory, and it is generally accepted. It would make a great difference in the deflection, sixteen or eighteen times as much in a 4½ ft. bar. On any theoretical basis you could not figure any difference on account of the curvature. There might be a difference, but no one would know it.

The following paper from James Christie, M. E., of the Pencord Iron Works, Philadelphia, was then read:

Heretofore we had depended on a simple transverse test, specimen, 1 inch square, 15 inches long, tested 12 inches between centers. Our criterion was that the specimen should endure 2,800 lbs., and deflect at least 1-10 of an inch before rupture. Latterly we have adopted a more perfect system. We cast at least three specimens, same dimensions as before, one end being cast on a chill. Specimens are numbered, depth of chill and shrinkage recorded. A tension test is made of one specimen, a second sub-

mitted to transverse pressure as before; the third is submitted to a drop test, supports 12 inches between centers. The deflection is measured under the impact, and the height of fall increased until the specimen breaks. A chemical analysis is made and this physical and chemical record is attached to the record of the mixture.

The President: Is there anything in hand for the next meeting in the way of a paper?

Secretary Evans: Not yet.

The President: Is there any one here who will volunteer a paper on any subject pertaining to the foundry business? I would also suggest, and that is a matter for the Executive Committee, that we should have at least one question for discussion at every meeting, and we might have more to accommodate any one wishing it. It is very desirable that we should inrcease the attendance at these meetings, and the best way to do it is to make our meetings as interesting as possible. I would suggest that we have one question for discussion at every meeting.

Mr. Meyer: I think there are some points in Mr. West's paper well worth taking up and studying.

Mr. Whitney: I think it a valuable point Mr. West brings out —that there should be some standard sizes of test bars and that they should be larger than 1-2 inch square in order to cover a reasonable range of quality of metal. I have only had a little time since the receipt of a copy of Mr. West's paper, and therefore have not been able to go into it as fully as it deserves. The analyses given in the paper are recorded according to the usual form without showing the percentage of iron. Of course, this may be calculated by difference—that is, by subtracting some of the elements given from 100. Though the error of all the determinations, however, is thus thrown on to the figure representing the iron, for the purposes of my remarks it would be well enough to consider that figure correct. By inspection of Table No. 7, in which Mr. West has arranged the various grades of metal in the order of their strength, it will be seen that the stronger metal has the most iron, and the others follow in order. With the exception of the stove plate, which comes a little out of the order of strength, from

a table I have prepared and will now read it will be seen that the iron is the highest in the strongest metal, and that the strength decreases with the percentage of iron except in the case of the stove metal, which does not agree with that statement. But it is evident that the ratios of the strengths of the bars is not the same as the ratios of the percentages of iron given, therefore the strength cannot be calculated from the iron alone. By an application of a formula which we have developed in our practice I have calculated the relative strength approximately from the analyses. These strengths I have also given in the list:

	Chill roll.	Gun metal.	Car wheel.	General mach'ry.	Stove plate.	Bessemer iron.
Iron	95.197	95.120	94.988	94.100	92.473	93.782
Strength of largest bar	5.013	4.355	4.263	3.786	3.011	2.860
Relative strength	100	87	85	75	60	57
Relative estimated strength	100	86	84	77	81.5	68

This table shows that it is becoming possible to figure the strength from an analysis, and I have little doubt that further study will give a figure which would cover the case of the stove plate also. I might mention that we have used a hexagon bar of 4 square inches sectional area. We used this shape as the angles of the hexagon are much less obtuse than the 2-inch square bar formerly used, and are far more satisfactory owing to the lesser liability to chill on the corners. Again, referring to the calculation of strength from analyses we now do it mainly by inspection and a rough table, but the calculation given in my list is made without reference to any table, and by the application of a general formula which, however, needs to be slightly amended to cover such mixtures as stove metal. The practical aspects of such figuring may be appreciated by an examination of a sample I now show you (handing a sample to the secretary). This bar was made up entirely by figuring from the analyses of the compounded materials. It consisted of 90 per cent. of scrap, including borings and turnings. A test piece was cast 2 inches diameter, 9 inches long and the tensile test turned from the center of this casting to

measure $1\frac{3}{4}$ inches diameter at the heads, and 1.128 inches diameter at the center. This broke at 37,000 pounds per square inch. Usually an iron of such particularly high strength is difficult to turn, but this metal machines very well, and, as you see, has a very bright spotless finish. Another point in regard to making mixtures of high strength is that they should not vary greatly in strength according to the size of the test piece. Such metal as this would give at least 25,000 pounds tensile strength, even though cast 4 inches square. It will be seen that I have only taken the strength relatively, as I do not appreciate Mr. West's method of calculating the strength of his bars. His results, however, are approximately comparative for the same size of bar, which serves my purpose in the list.

Mr. Prince: I cannot say that I learn much from Mr. West's paper. There is one thing called to my mind in his treatment of the subject. I think in the first paper I heard him read here—in regard to the use of the round bar as against the square bar Mr. Keep had been advocating so highly, he had a strong ground against the square in favor of the round bar. After the meeting I asked Mr. West this question: "What do you consider, then, the best size for the round test bar?" He said: "We have not got to that yet. I have not made experiments yet." The impression his paper produces on my mind is that he is making very strong statements from insufficient data. He has just a few experiments and is making rather general statements which are not backed up by the mass of experiment there should be. Mr. Keep seemed to have the same trouble. He would make a few experiments and generalize from those. It is not necessary to go over Mr. Keep's papers very carefully to pick flaws. You can find on the same page in some pages most contradictory statements. As a whole I think his work was valuable, but he has a way of generalizing from one experiment which is peculiar, to say the least, if he wants to bring out anything that he can stick to.

Mr. Evans: I have heard these papers and cannot think which is the proper size bar and which is the proper shape. Is it possible both may be right?

Mr. Prince: I can hardly say that I think the form and size of bar depends very largely on what work you are putting it to. Mr. Keep is using apparently in his work on stove plate the 1-2 inch square bar, and finds it the best. In other work it is far from being the best. If one person, after experimenting with different sized bars, finds one size the best he had better stick to it; it will give him the information he is after.

Mr. Davis: Some months ago I had occasion to break a number of bars and got more freaks in small sized bars than in larger ones. I also found a difference in the way the pattern was made. There was often a fault there that would give unusual results. The pattern I had most success with was cut in the center and fastened with a dowel pin. The small bars, I mean 1-2 inch and 3-4 inch diameter, gave bad results. We got some good results from 1 inch bars. We got better results from bars $1\frac{1}{8}$ inch than we did from larger bars. We have made them from $1\frac{1}{8}$ inch down to $\frac{3}{4}$ on the same iron. The bar that cast $1\frac{1}{8}$ inch diameter turned and fitted to the size it should be for the testing machine would sometimes pull 2,500 more than the other bars.

Mr. Whitney: What iron was it; a pretty hard iron?

Mr. Davis: Yes, a rather close iron. We used a certain percentage of car wheel scrap.

The meeting then adjourned.

PROCEEDINGS OF THE WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Western Foundrymen's Association was held Wednesday evening, December 16, 1896, at the Great Northern Hotel, Chicago. In the absence of the President, Wm. Ferguson, Vice-President, occupied the chair.

The Secretary reported as follows:

At the last meeting I reported having written to Mr. Martin Fox asking him to express his opinion on our Apprenticeship Committee's report. I have received from him the following letter in reply:

Cincinnati, O., Nov. 3, 1896.

Western Foundrymen's Association:

I am pleased to see that your Committee on Apprenticeship has decided in their report that "a recognized apprenticeship system is not only desirable, but necessary to keep up the standard of efficiency being called for in the foundry business." It will be remembered that on a former occasion I expressed similar views before the association. That in my opinion is the salient point of the whole question. The necessity for a recognized apprenticeship system once admitted the rest is mere matter of detail upon which all parties might be expected to come to a satisfactory understanding.

I have read over carefully the recommendations relating to the subdivision of the craft and the treatment provided for each and feel called upon to congratulate the committee on the thoroughness and care with which they have treated their subject.

No objection can be raised to the classification of molders made by the committee. Molding, like all other industries, has followed the modern tendency of specialization and the name molder nowadays conveys but a vague and indefinite idea of a man's mechanical occupation.

The age limit of 16 years is that which has been fixed upon by the molders' organization as the youngest age at which it is advis-

able that a boy should begin his apprenticeship, so that we agree upon that score, but I might say in passing that this limit would depend largely upon the development of the boy, and while a well developed body is certainly a most desirable desideratum in one who intends to follow molding it is by no means an absolute necessity, for, as it is well known, the best head is not always on the broadest shoulder, and I have in my mind's eye many of our foremost mechanics who, in physical development, are below the average; so that, while it is desirable, its lack is not of necessity a fatal objection.

Turning to a consideration of the provisions of the indenture I see little that is objectionable and much that is certainly praiseworthy in that drawn up for class (1) the general machinery molder, and if the provisions contained more generally prevailed they would, in a few years, raise the average skill of the American machinery molder to a standard second to none. I see but one place where I would suggest a modification and that is to change the period to be spent on the core bench from 12 to 9 months, and follow it by three months to be spent around the cupola. My reason for urging this is that three years is a short time to be devoted to actual molding in such a diversified field, and further that a young man in the last three months of his apprenticeship is then of most value to his employer, and is less likely to take kindly to the change from good work to the details of cupola practice, desirable though these may be.

And here allow me to express my strongest approval of the policy of making the apprentice to this branch of the trade put in some time on the core bench. Of late years there has been a tendency to depart from this custom and to look upon coremaking as something separate and distinct, in fact of the specialized sub-division of molding. As a result we have many of our younger journeymen to-day who though equal to any so far as skill in molding is concerned, are sadly at sea when questions affecting the cores they are to use are brought forward. It is not necessary nowadays, that a molder be as expert in the making of cores as a practical coremaker, but it is most essential that he know enough

about the general principles of their construction to allow of his discussion of methods suitable alike to his necessities and the coremaker or foreman's ideas.

The cupola, too, has in nearly every instance been neglected, and the molder permitted to learn in the hard school of experience the requirements of successful cupola practice, when such knowledge becomes necessary to him. When we consider how essential good melting is to ultimate results we cannot but agree that with a more widely diffused and intelligent knowledge of the subject, better progress would be made and many of the annoying circumstances attendant upon faulty melting would be avoided.

I feel, however, that only in the better class of foundries could we expect a complete system to be adopted, where quality of work is something more of secondary consideration. But even if its adoption be so restricted the trade would derive some benefit, in the more general demand for these higher grade mechanics as foremen or superintendents, or first hands in a shop.

Apart from this reluctance in adopting the system by employers, we have also to anticipate the objection from some of the apprentices themselves, who especially in the work about the cupola may be expected to raise some objections, and display an annoying indifference; add to this the inherent selfishness of those possessing valuable knowledge of this character when required to impart it to another and you have a combination that is no mean obstacle to be reckoned with.

The bonus system had its objection too, among them the unfair prejudices that frequently develop and the resentment thereby engendered; but still I am inclined to agree that the incentive furnished will in the majority of cases have a beneficial tendency.

In the indenture governing class (2) stove plate and agricultural implement molders, I take exception to the three year term of apprenticeship. The first six months might well and profitably be spent in working about the shop and cupola as suggested; the following year and a half he should work day work in making odd jobbing work, of which there is usually considerable in the ordinary stove shop, or on some of the common line of stoves, on a

floor beside a day work journeyman, or under the supervision of an instructor; he would then be able to do piece work during the following two years, being gradually advanced to the best class of work as his capability merits.

It is evident the committee in recommending the three year term of apprenticeship have fallen into the very common error that because machinery molding is of such a diversified character, and is continually testing the ingenuity and mechanical ability of the molder that therefore the fundamental knowledge to be acquired is more extensive and will require a longer period of education. This is scarcely a justified conclusion, for when we consider the superior quality of skill required to turn out later day stove plate castings, the deftness in the handling of tools, the good judgment to be displayed in gating, etc., the neatness and despatch to be acquired in an extensive field of labor from the box stove to the complex and ornamental heater, it would seem to indicate that four years from 16 years of age will be fully occupied in acquiring the necessary instruction and experience. The difference of mechanical ability is rather that of kind than of quality.

Similar arguments would apply to the agricultural implements molder and with greater effect because his work is more closely allied to machinery molding.

I cannot too strongly impress upon the association the necessity of putting the apprentice on day work till the third year, in fact it would not hurt if he were kept on till the fourth year. By going immediately on piece work the incentive to him is quantity for the sake of reward, quality being relegated to a place of secondary importance. This is not as it should be and accounts in no small degree for the large number of stove plate molders who are found unequal to the task of producing the class of work necessary for the best quality of ranges and heaters. The day work system removes this incentive during the most receptive period, and neatness and superior quality will be given the first place. Once acquired there is scarcely any danger of it being lost for speed will in after years readily combine.

The discount off board prices recommended when the apprentice begins under the piece system are very liberal. And now we come

to the third indenture—bench and brass molding. In a consideration of this branch of the trade we are met with a somewhat peculiar set of conditions for we might fairly claim that this class could be subdivided, and if the indenture of the committee applies to those who work with a machine, or exclusively on plate or gated work, little objection could be raised, for in the majority of what we might call the specialty shops, no specified period of apprenticeship is recognized, the man being advanced in accordance with his increasing skill. But if it takes a wider range and applies to that class of bench molding which takes in general jobbing work, it is altogether inadequate. This, I feel will be at once appreciated by those familiar with the class of bench work referred to. The ingenuity and skill required is then something more than a mere part of an automatic machine and becomes a directing influence. A visit to any of the shops where such a class of work is made, where molders when they use them must make their own match and lay out their own job will convince the most skeptical. And when we speak of turning out a good mechanic in a certain branch of molding should it not refer to the highest grade of that class rather than to the lowest? A machine-puller, as they are usually called, who can do nothing else, scarcely merits the name of mechanic, but a first-class bench molder is one and no mean mechanic at that, and in my opinion could very profitably fall in line with the other classes and make the terms of apprentices uniform in all branches of the trade, with the one year additional, as suggested, for those who desire to learn loam as well.

Yours, etc., MARTIN FOX.

The following letter from P. W. Gates, President of the Gates Iron Works, is also relative to the report of the Apprenticeship Committee:

Chicago, Ill., Nov. 5, 1896.

Western Foundrymen's Association:

I read with much interest the report of your committee to your society in relation to the apprenticeship system, and I heartily endorse same. There is no matter which needs more attention than this, and it is of the utmost importance both to the manu-

facturer and the foundryman that some efficient system is adopted.

There is one suggestion which I should like to mention to you, namely, the matter of inducing the graduates of the training schools becoming apprentices, thereby becoming thoroughly practical in the trade. It is my belief that some special inducement should be held out to these young men, first, from the fact that having acquired a higher education they are capable of imbibing instruction more readily than those of less attainments. At the same time they are supposed to have had the benefit of shop work, which to a large extent gives them the fundamental ideas, and therefore relieves the foundryman of a large amount of work. It is my belief that the graduate of a manual training school, if he is graduated from the shop work in the department in which he proposes to become an apprentice, would be able to do as much in six or nine months in any event, as any ordinary apprentice would in twelve. I therefore suggest to your committee the advisability of shortening the time for such applicants.

Please also allow me to suggest that from a talk which I have had with the heads of one of the manual training schools of this city, it might be advisable for your association to appoint a committee to consult with the principals of the different schools in the vicinity suggesting to them such methods as would be most likely to make such work as is done in your line practical. I believe that all of the training schools would be glad to have a committee from your society visit them at least once a month, looking over their work and making such suggestions as the committee deems advisable.

For my own part would say that I would be glad to recommend to my company the granting of a day at proper periods, to some competent, practical man in our foundry department, to form a member of such committee, as I believe in the future we shall have to look largely to the training schools for our workmen, and therefore it is expedient to have the work as practical as possible.

Very truly yours,

P. W. GATES.

Mr. Sweeney: Mr. Gates' letter touches on a phase of the apprenticeship question that I was about to call attention to. I would

like to ask what credit shall be given to the apprentice who has served a portion of his time in the manual training school or elsewhere? We are beginning to see that the manual training schools are the places from which the good assistants will be recruited in the future. Particularly we find this true in the drafting departments. A young man is taken from school and put into the drafting room and is brought along as fast as he can come. If you should take two boys, one who has been through the training school and the other who had no experience whatever, you would naturally give the one who has been through the training school the preference. This was brought to my mind through the application of a young man from one of the training schools. He was very frank in telling me his experience. He had gone to work in a shop in the city by arrangement with the foreman, I think, by which he was to work for a short time, six months or so, at a specified amount and then was to be brought along; but had only worked three or four days when that arrangement was annulled by a superior officer. The training schools are doing good work. I know that because I have been able to get boys from the training school that were much better than if they had no experience at all.

Mr. Ferguson: I would state in behalf of the Committee on Apprenticeship, that we canvassed this question very thoroughly before making the report—in fact we were three months or more in getting the opinions of the leading foundrymen in the country. We drew up a general letter and sent it to each of the prominent foundrymen in the country asking for their ideas. Strange to say that in all of the communications this phase was never brought up, but immediately upon Mr. Gates' mention of the matter to me I could see the force of it. I fully agree with the letter that he has sent in.

Mr. Sorge: I would move that these letters, the one from Mr. Martin Fox and the one from Mr. P. W. Gates, be referred to the Committee on Apprenticeship for consideration, and that they report at the next meeting as to the advisability of changing their report in conformance with these letters.

The motion being duly seconded was carried.

Mr. Ferguson: I would like to state that the committee is at present in a crippled condition, as we have received the resignation of one of the members. I will name Mr. Thompson to fill the vacancy caused by the resignation of Mr. Oehring.

Mr. Vrooman: I would like to say a word in regard to the point in Mr. Fox's letter in respect to putting the apprentice three months around the cupola. It appears to me that putting a boy or apprentice three months around a cupola will not give him many ideas of melting iron. The idea that seems to be conveyed by Mr. Fox and Mr. Gates is that the object of the committee in forming its apprenticeship system is to make founders instead of molders, and I have understood the cry to be that we have no good molders. I agree with Mr. Fox that there should be a universal term for all without any discrimination.

Mr. Sorge: In regard to the practice of putting a boy on the cupola for three months, my experience has been that it is a very good thing. You put a boy on the floor and make him mold and he afterwards meets a number of things in the course of his work which are to him a great deal like Greek letters. You put him on the cupola and, although you cannot make a thorough melter of him, you give him an idea of the operations going on at the cupola, he learns to watch the process of melting and by a contact with the man who is doing the work will pick up the reason why the man will make changes in his practice. Although he will not be a competent melter, he will get a number of ideas and you can put him there in an emergency.

Mr. Frohman: I think Mr. Gates' idea is very good if it can be carried out. The boy emanating from the technical school does not want to be a molder or a foreman, but the general superintendent of the shop. I know of two or three instances where young men have graduated that have held no other position but that of superintendent and had no practical experience. I think it is going to be a hard matter to get your apprentice from the technical schools. Another thing, a young man does not want to go into a foundry because he thinks he does not come in contact with the proper kind of people; he does not get the proper ideas; he would

rather go into the machine shop where he thinks he meets a better class of people. I spoke to Mr. Fox on this subject and he thinks in order to get good apprentices we will have to elevate the molders and the helpers.

Mr. Sorge: I would like to make a little correction. A technical school is not a manual training school. Mr. Gates speaks of the manual training school. There is a vast difference between the so-called technical schools. The manual training school is supposed to give the boy a beginning in a trade, while the technical school is supposed to give him a profession.

Mr. Frohman: In the manual training school the foundry practice is the smallest part. They spend two or three hours in the other shops where they only spend a very short time in the foundry.

Mr. Sorge: Mr. Gates' idea is to push foundry work in the training schools.

Mr. Frohman: The trouble is that the foundry is neglected entirely. In the south they have more foundries in their schools than in any other place in the country.

Mr. Ferguson: I believe it is a part of the mission of the Western Foundrymen's Association to see that these things are taken care of. Mr. Gates suggests that the association become interested in the manual training schools.

Mr. Frohman: The complaint is made that foundry work is such dirty work and that the boys have to wash up before going to their studies and they do not like to do it. They only have a short time in the workshop and the rest of the time is spent in the study room. The trouble is that they do not have enough time in the former place.

Mr. Sorge: I think the Committee on Apprenticeship will go into the matter very thoroughly and consult with all the schools they can and give us the benefit of mature thought upon the subject.

The secretary then read the report of the Committee on Drying Cores after making the following statement:

I would like to state in advance that this tentative report by the committee is not final, but the committee thought it would be advisable to get this matter before the Association. The whole report is subject to revision and correction later on.

Report of Committee on Drying Cores.

The best temperature at which to dry and bake cores we have determined from a series of tests made in different ovens, and while we found quite a variation in the different portions of the ovens, our final deductions lead us to believe that 350 to 400 deg. Fahr. is the best temperature at which to bake cores thorougly. This temperature applies to all sizes of cores, as we find the only difference necessary between large and small is settled by the length of time they are left in the oven. That is to say a core 1-inch in diameter and one 12-inches diameter will bake equally well at the temperature given, only it will take the 12-inch core at least twelve times as long to bake as the 1-inch. It is our opinion that each shop could provide for itself a tabulated form, giving the length of time it would take to bake the various sizes of cores provided a stationary temperature could be obtained.

Mr. Thompson of your committee has kindly supplied us with a tabulated sheet of temperatures as taken in the core oven of the Link-Belt Machinery Company's foundry. The oven is 18 feet long, 11 feet wide and 8 feet high and is fired with coke at floor level in center at one end.

Temperatures in the core ovens of the Link-Belt Machinery Company's foundry:

	Aug. 6.		Aug. 7.		Aug. 8.		Aug. 10.		Aug. 11.		Aug. 13.		Aug. 14.	
Time.	Top.	Bot.	Top.	Bot.	Top.	Bot.	Top.	Bot.	Top.	Bot.	Top.	Bot.	Top.	Bot.
7 p. m.	240	150	260	150	270	150	240	110	300	220	240	180	250	180
8 p. m.	420	260	350	200	320	210	860	180	330	300	300	220	340	270
9 p. m.	420	270	360	220	320	220	390	220	360	370	320	340	350	280
10 p. m.	420	270	380	240	320	220	390	220	380	280	330	360	340	300
11 p. m.	420	270	380	240	320	220	390	220	380	380	330	390	320	300
12 p. m.	420	270	380	240	300	210	390	220	380	360	330	410	320	300
1 a. m.	400	260	350	230	300	210	370	220	360	340	320	380	300	290
2 a. m.	380	250	...	...	260	200	340	220	320	340	300	340	280	290
3 a. m.	340	240	320	210	250	180	340	200	280	330	260	300	260	290
4 a. m.	320	220	300	200	240	180	300	190	240	300	240	270	240	280
5 a. m.	280	200	300	200	220	160	270	180	210	270	200	250	220	270
7 a. m.	270	190	280	240	180	140	260	170	200	250	190	240	200	250

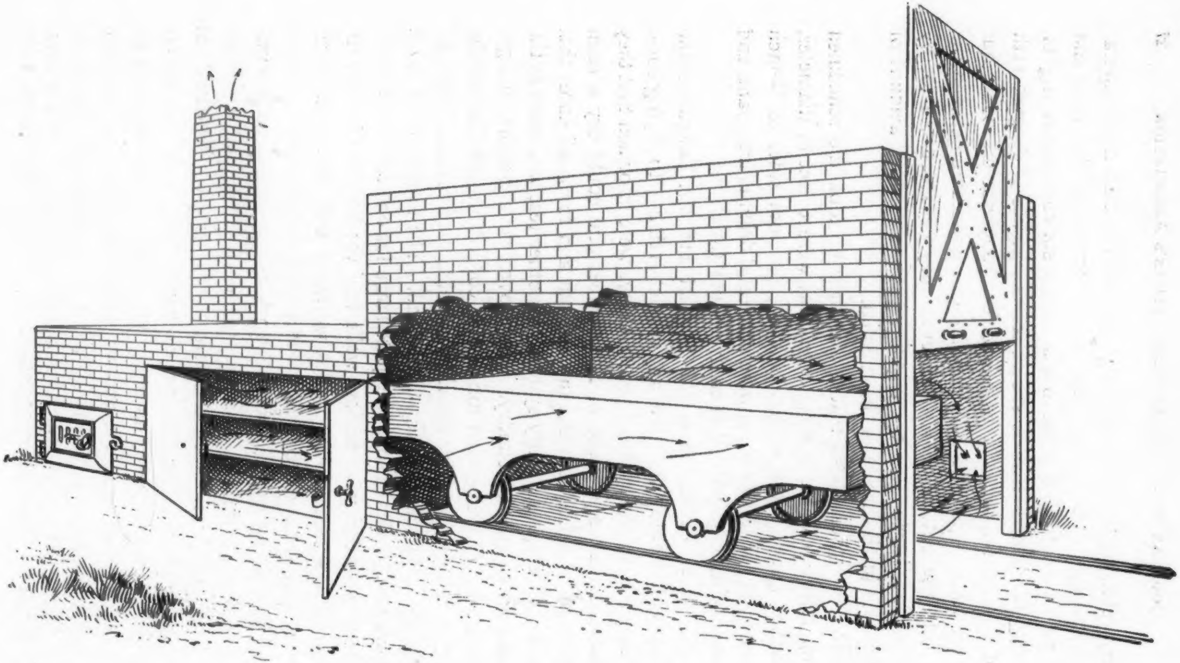
Fuel used. 270 pounds. Fuel used. 270 pounds. Fuel used. 200 pounds. Fuel used. 270 pounds.

By referring to this table you will observe that the temperature was taken both at the top and the bottom of the oven, and for each hour from 6 p. m. to 6 a. m. for six consecutive nights. It will be noticed there is shown for the nights of August 11th and 13th, about an even temperature throughout the oven, but on all other nights the difference is quite noticeable between the top and the bottom. This, however, may be accounted for by the draft conditions on the nights mentioned, as the amount of coke used in all cases was about equal.

Mr. Thompson states that at the time he took the scheduled temperatures he was baking cores that were 6 feet in diameter, 9-inches thick at the center, tapering on both sides to ½-inch at outer edge. These cores were made and dried in iron pans, and were all thoroughly dried in twelve hours' time.

We are also indebted to Mr. Stantial and Mr. Lukens of the Illinois Malleable Iron Company for data relative to drying cores by steam heat, and by these gentlemen we were informed that they maintained a temperature of 275 degrees and could dry a resin sand core 2 inches diamater in one hour and for small cores that seemed a very satisfactory system. Another test was made at the Gates Iron Works foundry. This oven is of peculiar design, because of its being used for drying cores from smallest to the largest and designed for shelving and side doors at back end and carriage and sliding doors at front end. The sketch of this oven shows that its dimensions are quite large for one small fire place.

It is provided with hollow walls half the height of the oven to assist in retaining heat, and it works so well that burnt cores are almost unknown in this foundry. In constructing ovens in foundries doing special lines of work, we believe it both possible and practicable to so design and build them, that a definite and uniform heat can be maintained, thus making it possible to set the time for each size core to remain in and be thoroughly baked. The conditions, however, in a general or jobbing foundry are different owing to the various size cores in use, and it is not possible to arrange matters so as to have all the drying in the day time. Hence in foundries of this class, night usually finds the core oven filled from bottom to top with all shapes and sizes,



Core Oven in Use at the Gates Iron Works.

so that even if we knew the desired length of time to dry each different size, it would become necessary to leave help to handle them from the oven as they became dried. Whether this would prove profitable would have to be proved by each individual foundry.

WM. FERGUSON, Chairman.

Mr. Pettigrew's Report.

The question of the best temperature at which cores should be baked or dried is one which each foundry ought to be able to decide for itself. The work in each separate foundry is so different in details, there can be no hard and fast lines laid down for all.

In a regular jobbing shop, the cores may cover a lot of pipe cores, cylinder cores from body cores to port cores, that will have to go into the oven with dry sand molds that have to be dried for next day's work and all expected to come out just right.

There is so much coal dumped near the fire door of oven, which the watchman or other employe is expected to put into the fireplace during the night and which experience has shown will generally do the drying required, but if there are any extra large cores or molds, it will be found the small ones are dried and perhaps burned, but the larger ones are not dried enough to be used that day and may need another night's firing, which may burn them or not according to the time and ability of the men in charge or the material of which they are made.

In drying molds without any flour in the sand mixture, I have found that a temperature of 400 degrees continued from twelve to fourteen hours will generally drive all the moisture out, but where there are cores in the same oven with one part flour to ten or twelve parts of sand, the cores will be all burned and not fit to handle.

In this western country the general run of foundries have only green sand work with comparatively small cores. The ovens are, as a rule, small, and from a couple of riddles of scrap cuttings from the carpenter shop to 1000 pounds of coal or refuse coke that is too small for cupola we will furnish all the heat re-

quired, but it will be found that nearly 500 degrees of heat will be required from 4 to 6 hours to thoroughly bake cores as generally made with a mixture of sand and flour from the small cores generally used to those of about 12 inches diameter. We have seen cores dried successfully in a steam heated room with a temperature of 240 degrees where there was no danger of burning, and think that where exhaust steam could be used advantageously much fuel could be saved in most foundries, especially where a large amount of small cores are used constantly.

The drying of cores, like every other thing in a manufacturing concern, to be successful, needs care and attention, something which it seldom gets. Therefore, I think that the waste heat which goes up the smoke stack from a boiler or from the exhaust of an engine, could be used successfully with proper care and attention, and with proper appliances could be used with great economy in foundry practice.

JOHN PETTIGREW.

Mr. Thompson: The table is not correct because we had two different pyrometers which when cool did not register alike, and the supposition was that by deducing the difference we would get the exact temperature of the oven. That seemed to hold good for the first five days of the experiments, from the fact that they registered so nearly alike with the same amount of fuel. But on changing the pyrometers it was found that the heat was greatest in the lower part of the oven, which I think should not be. I cannot account for the differences except that the pyrometers are not correct. I understood that if a pyrometer registered 200 degrees at the start and went up to 400 degrees it registered 200 degrees of heat. It is evidently not so.

Mr. Ferguson: Even if the report is not right, in order to prove that it is not right other people will have to go through the same experiments that the committee have and we will get their data and bring out more knowledge on the subject of temperature. The first thing that struck me was that the relative temperatures

were about the same at all times. It shows that the thing was not working very far out of the way.

It was moved and carried that the committee be continued and that the secretary be instructed to send out for the committee letters to members of the Association requesting them to make experiments on this subject and report to the committee.

Mr. Johnson: I do not suppose it matters much what kind of fuel is used, but it might be interesting to get a report from foundrymen using oil and gas, as it would broaden the subject a little. Go down in the oil and gas regions and see what they have to say.

Mr. Sorge: It seems to me that you are broadening the scope too much and getting into things that are of a different character. The question of fuel is not involved in temperature. If that is to be gone into I think it should be gone into separately. The meeting then adjourned.

PROCEEDINGS OF THE NEW ENGLAND FOUNDRYMEN'S ASSOCIATION.

The regular meeting of the New England Foundrymen's Association was held at the United States Hotel, Boston, Mass., Wednesday evening, December 9. There were 21 present, and 16 foundries were represented. Officers were nominated for the ensuing year, after which B. N. Shaw, of the Walker & Pratt Company, entertained those present with a brief outline of the way the cost of stoves is kept as adopted by the National Defense Association. Mr. Walker, of the same company, then asked for a discussion of the following topics: 1. "Is it Necessary, in Providing Wash Rooms for Molders, to Have Separate Apartments in Same?" 2. "What is the Best Method to Shade Windows on the South Side of Foundries to Prevent the Glare of the Sunlight?" After an interesting discussion on the above subjects the meeting adjourned. The next meeting will be held at the United States Hotel on the second Wednesday in January.

PROCEEDINGS OF THE PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The Pittsburg Foundrymen's Association met in the rooms of the Builders' Exchange on Monday evening, December 28, with President Robert Taylor in the chair.

The paper of the evening, read by A. B. Harrison, Ph. D., chemist of the Clinton Iron & Steel Co., was on "Freaks of Foundry Iron." It is as follows:

"Freaks of Foundry Iron."

Our subject, "Freaks of Foundry Iron," is a peculiar one. We might truthfully say that there are no "freaks" either in nature or in applied sciences. Webster says a freak is a "capricious change," "a whim." We use this term, however, meaning a result unlooked for and not explained by previous conclusions. Freaks are the effects either of transgressed laws or of resultant laws. We purpose, then, simply to submit some analyses of foundry irons and the results obtained in a series of physical tests. Before proceeding further, it will be necessary to give a brief description of the tests and test pieces used:

Fluidity.—To determine the fluidity we use two tests. The iron must be fluid enough to travel a distance of 24 inches, using a pattern 24 inches long, by two inches wide and 3.32 of an inch thick. Test pieces are always made in pairs. To further test the fluidity we use a pattern having the same thickness and length but being only one inch wide. Both patterns have a three-quarter-inch hole about three inches from the end, giving a chance for the iron to show any tendency to "cold shot."

Softness.—The size of pattern used for test for softness is 24 inches long by two inches wide and one-eighth of an inch thick, with three-quarter-inch-hole one inch from end. These strips, as well as above fluidity strips, are tried with a file, and any hardness of edges or ends noted. All these strips are gated at one end only.

Shrinkage.—For shrinkage a bar one-half inch square by 12 inches long, cast between metal yokes, is used. This bar is then placed, when cool, between the yokes, and distance between yoke and bar measured with a wedge-shaped gauge reading to one-thousandth of an inch.

Tensile Strength.—Bars 1¼ inches square by 12 inches long, reduced at middle section to a diameter of one inch are used. These are cast in pairs.

Transverse Strength.—Bars one inch square by 24 inches long are used for transverse strength tests, the bars being broken on 12-inch centers.

All of these castings are made in sand used for general bench-work, being cast horizontally, and, excepting shrinkage bar, gated at one end.

High Silicon.—It has been generally acknowledged that irons high in silicon are soft but weak. We will submit, however, two analyses with their results, showing high silicon in each, the second, however, having more sulphur by many times.

	Si.	S.	P.	Mn.	Grap. C.	Comb. C.	Tensile stren'h.	Trans. stren'h.	Fluid'y.	Softness.
No. 3,155	3.20	.005	.54	.88	3.60	.06	15,280	2,500	o.k.	1-8 o.k.
No. 4,595	3.50	.090	.54	.80	3.60	.06	23,450	3,000	o.k.	1-8 o.k.

You will notice from these a great difference in tensile strength. Comparing them you notice the great difference in sulphur content, the other ingredients varying but little. We might deduce from this the large amount of sulphur in the second gave the increased strength. But wait a moment. Here is another iron varying but little in analysis from the first and weak iron, but varying greatly in strength:

	Si.	S.	P.	Mn.	Grap. C.	Comb. C.	Tensile.	Transverse.	Fluid'y.	Softness.
No. 4,299	3.05	.008	.53	.71	3.60	.12	29,170	3,500	o.k.	1-8 o.k.

In all these tests the strips were fluid, giving good clean castings, but the "3-32 inch" strips were hard on extreme ends, contrary to what might be expected.

Here are three irons varying but little except in sulphur, but giving contradictory results. Is this not perplexing? The solution I leave with you.

With the above as examples of high silicon irons we will now submit irons of much lower silicon content:

	.Si	S.	P.	Mn.	Graph. C.	Comb. C.	Tensile.	Transverse.	
No. 3,643	1.20	.029	.71	.65	3.60	.18	28,025	3,100	
No. 2,084	1.15	.026	.69	.42	2.60	.24	22,420	2,400	All
No. 4,792	0.85	.026	.52	.73	3.50	.37	24,446	2,650	strips
No. 1,599	0.85	.021	.94	.74	3.40	.28	23,440	2,500	fluid.
No. 1,336	0.80	.043	.55	.52	3.35	.24	17,961	2,650	

You will notice that these irons gave good tests, yet hardly any one would desire to use irons of such composition.

Phosphorus.—We will not dwell long on phosphorus as an ingredient, only submitting two analyses showing high percentage against low percentage:

	Si.	S.	P.	Mn.	Graph. C.	Comb. C.	Tensile.	Transverse.	Fluid'y.
No. 2,147	2.40	.018	1.01	.58	3.50	.10	20,760	2,280	o.k.
No. 4,144	2.50	.019	.41	.65	3.25	.10	20,910	2,850	o.k.

You will notice there is but slight difference in the tensile strength, the greatest difference being in the transverse strength. The fluidity and softness of each iron were satisfactory.

Carbons.—We will submit but two tests, from the many that could be produced, showing variation in graphitic and combined carbons. Notice the tensile and transverse strengths:

	Si.	S.	P.	Mn.	Grap. C.	Comb. C.	Tensile.	Transverse.	Fluid'y.	Softness.
No. 4,270	2.30	.019	.69	.78	3.80	.09	32,085	3,100	o.k.	1-8 o.k.
No. 4,369	2.05	.015	.55	.84	2.90	.32	33,104	3,200	o.k.	H'd.

This is a case that puzzles one to explain results. We could give many instances where phenomenal strength would be expected, judging from analyses, but where weakness was found, and many cases where we expected weak bars but found high tensile results. We desire, however, to treat briefly of shrinkage.

	Si.	S.	P.	Mn.	Graph. C.	Comb. C.	Tensile.	Trans-verse.	Shri'k
No. 2,161	2.85	.014	.66	.64	3.40	.11	20,000	2,300	.155
No. 2,131	1.75	.020	.67	.43	3.50	.18	20,760	2,250	.157
No. 2,134	1.65	.020	.67	.50	2.95	.20	21,400	2,300	.158
No. 2,147	2.40	.018	1.01	.58	3.56	.10	20,760	2,280	.155
No. 2,177	2.20	.020	.90	.73	3.05	.18	21,783	2,650	.155
No. 2,380	2.15	.003	.57	.55	3.60	.08	19,230	2,510	.155
No. 2,088	1.55	.014	.58	.54	4.10	.18	......	......	.148
No. 2,128	4.45	.046	.86	.45	3.25	.18	......	......	.145
No. 2,358	2.50	.017	.51	.66	3.15	.15	......	......	.145
No. 2,194	2.10	.014	.69	.57	2.75	.20	......	......	.145

You will notice the varying amounts of usual impurities but the uniform shrinkage. High phosphorus and low phosphorus, high graphite and low graphite are shown, but shrinkage is the same. As we desire to treat of several more peculiarities of irons, we will not dwell longer upon this one subject, although very interesting and full of value, but we will speak of the

After-Treatment of Test Pieces.—We merely clean our bars from the adhering sand and then pull them. Having read in one of the trade journals of the effect of "tumbling" test bars in the barrel, we decided it might be interesting and useful to gather some data ourselves. So we have had several such tests made, taking one of the tensile bars for usual test, putting the other bar (always casting these in pairs on one gate as mentioned before) in the barrel, tumbling them once a day. The results are as below. We do not attempt to explain them. We did not try many bars with prolonged tumbling, as we were at the time very busy and could not give more time to the matter. It would have been interesting, no doubt, to try a number cast upright, and tumbled for the same period in the barrel, to see the effect of the different strains in the same iron and if in fact any general rule could be decided from such data.

Notice the varying precentage of increase and decrease in strength of tensile bars. We have not submitted the analyses, as that would make this talk very tedious and long, but these tests were made daily for a period of two weeks, not trying to select abnormal but rather normal irons:

	Tensile strength. Before.	After	Increase %.	Dec. %.
No. 4,684	25,462	28,780	13.03	....
No. 4,689	30,557	30,557	nil	nil
No. 4,696	22,930	24,827	8.27	....
No. 4,699	26,865	31,703	18.00	....
No. 4,744	24,010	21,640	....	9.87
No. 4,752	25,040	24,323	....	6.23
No. 4,757	22,165	29,793	34.41	....
No. 4,769	25,592	24,191	....	5.47
No. 4,777	28,138	23,450	....	16.66
No. 4,784	25,462	24,572	....	3.49
No. 4,792	24,446	22,039	....	9.84
No. 4,807	28,025	28,393	1.34	....
	Transverse strength.			
No. 4,744	2,400	2,650	10.41	....
No. 4,733	2,800	3,150	12.50	....
No. 4,729	2,800	3,150	12.50	....
No. 4,722	2,400	3,125	30.20	....
No. 4,797	2,720	2,900	6.62	....
No. 4,792	2,650	2,830	6.79	....
No. 4,644	2,400	2,800	16.66	....
No. 4,059	2,200	2,850	29.54	....
No. 4,807	2,350	3,400	44.68	....

We also thought it would be interesting to note the difference, if any, in the way the transverse bar was placed for breaking. So we had bars cast in pairs. One of each pair was tumbled, and the other was only cleaned in the usual way. We then took each bar and broke it, first with the "cope" side up, then with the "drag" side up. Notice the results:

		Before.	After.	Inc. due to tumbling.
No. 4,811	Cope	2,460	2,610	6.09 %
	Drag	2,560	2,620	2.34 %
No. 4,818	Cope	2,660	2,945	10.71
	Drag	2,750	2,950	7.27

This shows that a greater resistance to rupture seems to exist when strain is applied to drag side of bar, but after tumbling in the barrel there appears to be no practical difference. In No. 4811 the increase in strength of drag over cope was 4.06 per cent, while in bar No. 4818 the drag side uppermost gave 3.34 per cent of an increase.

You might now ask, How can the chemist then be of practical use to the founder? In many ways; and in closing permit me to refer to several cases where the chemist at once located the cause of the trouble. It is usual in cases of hard, brittle castings to blame the pig iron used as the cause. We desire to submit an analysis of cast iron, of the scrap added in the mixture, and of the coke used to melt the same; also analysis of the pig used. The mixture was 60 per cent pig, 40 per cent scrap:

	Si.	S.	P.	Mn.	Graph C.	Comb. C.
The scrap analyzed...	1.80	.026	1.02	.41	3.10	.28
The pig " ...	1.65	.017	.69	.47	3.45	.11
		Fixed C.	Ash.		S.	P.
The coke "		84.45	13.35	...	1.67	.022

Please note the sulphur in pig and scrap irons; also sulphur in the coke. Notice that the graphitic carbons are excellent, and we would expect from the mixture a good soft casting. Here is the analysis of the casting obtained which, it is needless to say, was hard and brittle:

Si.	S.	P.	Mn.	Graph. C.	Comb. C.
1.75	0.156	1.12	.380	2.25	1.20

This, you say, is an extreme case. Yes, but the reason we cite this one is that troubles of this nature frequently arise. In fact, I could mention numerous cases where the founder was led astray by good-looking coke, the same coke having caused him much loss by bad castings, while pig iron was blamed for all the trouble. Therefore, we maintain that it is wise in cases of sudden and unexpected changes in product, using the same materials, to have not only the pig iron analyzed but also the coke. In our opinion it will be found that the coke will vary more than the pig iron. We had one sample of foundry coke submitted for analysis which contained over two per cent of sulphur.

In another case of trouble in a foundry we found that the principal cause was in the water used, it being high in sulphur compounds, and consequently sand, in course of time became highly impregnated with these compounds and caused trouble.

No doubt, many cases arise in your minds where it was the little, and therefore unlooked for, causes which produced your difficulties.

Owing to the statistical nature of the paper it was deemed wise to postpone discussion of the subject until the printed copy could be put in the hands of the members. The discussion will, therefore, be taken up at the next regular meeting—the fourth Monday night of January.

CONTRACTION AND DEFORMATION OF IRON CASTINGS IN COOLING, FROM THE FLUID TO SOLID STATE.*

By FRANCIS SCHUMANN, Philadelphia, Pa.

One of the most serious and annoying difficulties to the iron foundry is the tendency of castings to deformation, due to unequal cooling and consequent unequal contraction, excessive initial stresses, if not cracked castings, often resulting, no matter how carefully molded or with what care the iron is selected and manipulated.

Our knowledge as to the causes has been but vague, notwithstanding the thought and attention given the subject.

The writer, impressed with the importance of the matter, and having opportunities for observation and experiment through his connection with foundries where great diversity in the form of product resulted, decided to investigate with a view of discovering what laws of physics applied and in how far the cause and effect were determinable and controllable.

After some twelve years of observation and research the writer is enabled to submit the result of his labors, which it is hoped will prove of practical use to the engineer and foundryman.

Cast iron, as well as all other bodies, with but few exceptions, expands or contracts equally in all directions, with the increase or decrease of its temperature, respectively. Hence the proportions of a body, whether the temperature increases or decreases, remain alike. At moderate low temperatures, from 32 degrees to 212 degrees Fahr., the change is directly as the temperature. At high temperatures the changes are greater than the changes in heat.

Contraction takes place just when incandescence disappears, or when the color changes from red to black, and continues until the temperature is normal to that of the surrounding mediums.

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*Abstracted from a Paper read before the American Society of Mechanical Engineers at the New York meeting (Dec., 1896).

A prism cast in a sand mold will maintain its alignment, after cooling in the mold, provided all parts around its center of gravity of cross section cool at the same rate as to time and temperature.

Deformation is due to unequal contraction of the elements of the cross section surrounding the center of gravity of the section.

Unequal contraction is due to unequal cooling, causing, or tending to cause, initial stresses in the elements of the prism, resulting in deformation or rupture.

The rate of contraction between the fluid (heated) state and the solid (cold) decreases with the volume or mass of the casting, and inversely as to time of cooling.

Rapid cooling tends to increase the density of the iron; the crystals are diminished in size, and the fracture denotes greater compactness, with more evenness of surface and less ruggedness. The color tends towards white, denoting a change of carbon into the combined state at the moment of solidification. The size of crystals decreases with an increase in combined carbon. Its resistance to impact is lessened, and the rate of contraction is increased.

Slow cooling develops larger crystals, less density, and increased ductility. The fracture is dark or more gray in color, the surface uneven and rugged, and the carbon is in a more free state. The contraction is lessened, and the casting has greater resistance to shock, although its resistance to a quiescent cross-breaking force may be less.

In any prism, variations in density may occur by reason of differences in the rate of cooling, the more rapidly cooling part being more dense, made so by the molecules drawn from the still fluid part of the casting which, cooling later, will be less dense or with a diminished number of molecules. The molecules in adjusting themselves follow and flow in lines coinciding in direction with the waves of cooling, being from a high to a lower temperature, thus tending to create a void and lessening the density of those parts which cool slower.

The rate of cooling, or dissipation of heat, is uniform around the perimeter of the cross section.

The total amount of heat to be dissipated per unit of perimeter of section may or may not be uniform or equal, depending upon the character of the cross section.

The greater the amount of heat to be dissipated per unit of perimeter the slower the cooling.

A plane of neutral or mean action, relative to the total dissipation of heat, passes through the center of gravity of the cross section. In symmetrical sections the action is alike on either side of the neutral plane, while in unsymmetrical sections it will, or may, vary.

The dissipation of heat through the perimeter of a section follows wave lines perpendicular, in direction, to the perimeter.

The amount of heat to be dissipated per unit of perimeter varies in proportion to the volume or mass of the prism of which the respective unit forms the dissipating side.

The relative amount of heat dissipated in a prism, per unit of time, varies in proportion to the dissipating surface of the perimeter divided by its respective volume of cross section.

The crystals that form in cast iron, when changing from the liquid to the solid state, have the tendency, when no disturbing causes interfere, to form themselves into regular octahedrons, or double four-sided pyramids, with their bases joined.

Their size varies, the mean increasing with the slowness of cooling. The long axis of the crystals tends to adjust itself perpendicular to the plane of cooling surface of the casting. Thus, in a cylinder the axis would coincide with the radial lines, while in a square prism, the axis of the crystals being perpendicular to the four sides, will tend to flow apart on a plane bisecting the angle of two sides; on this bisecting plane the casting will be less dense and of diminshed cohesion.

A prism, unsymmetrical in section, in which the proportion of cooling surface to mass varies around the centre of gravity of the cross section, will have the greatest proportion of smaller crystals in the parts cooling the quickest. Where the change in the rate of cooling is greatest will be the place of greatest interference to the natural adjustment of the crystals, as to size and position, and hence the place of least cohesion.

Contraction is in a direct relation to the rate of cooling and size of crystals. The more rapid the cooling the smaller the crystals and the greater the contraction.

In any prism, unsymmetrical in section, composed of a smaller mass joined to a larger, the greatest longitudinal contraction will occur in the larger mass. This apparent contradiction to the general law, that contraction decreases with the mass and rate of cooling, is explained when we consider volumnar contraction. The larger mass will have its rate of contraction equal in all directions; the smaller mass is restricted in its contraction longitudinally by the larger mass at the point of uncture of the two masses, but maintains its greater rate of contraction transversely; were the transverse rate the same as that of the larger mass, its longitudinal contracton would be the same, but its transverse rate being greater, the excess in volume flows in direction of length, resulting in a greater length, after cooling, of the smaller mass.

When the rate of contraction in the elements of the cross section of a prism are known, the resulting change in alignment and initial stresses, due to the differences in contraction, can be determined.

The line of mean contraction passes through the centre of gravity, or neutral plane, of the cross section.

In unsymmetrical sections the centre of action of the maximum and minimum contraction coincides with the centre of gravity of the area elements that are separated by the neutral plane which passes through the centre of gravity of the whole section.

Modifying causes that affect the results obtained by the application of the preceding laws are: Imperfect alloying of two or more different irons having different rates of contraction; variations in the thickness of sand forming the mold, which is the medium for conducting the heat from the surface or perimeter of the cross section; when the prism is cast in a horizontal position, and thin layers of sand at top and bottom affect the dissipation of heat, which becomes unequal by reason of the difference in circulation of air between the upper and under external surfaces of the mold, the upper surface dissipating the greater amount of heat; the position and form of cores, which tend to resist the

action of contraction, also the difference in the conducting power between moist sand and dry-baked cores; differences in the degree of moisture of the sand surrounding the prism, especially when small in mass; unequal exposure by the removal of the sand while yet in the act of contracting; flanges, ribs, or gussets that project from the side of the prism, of sufficient area to cause the sand to act as a buttress, and thus prevent the natural longitudinal adjustment due to contraction; in light castings of sufficient length the unyielding sand between the flanges, etc., may cause rupture.

Carbon is the most active element, when in the combined state, to increase the rate of contraction. As strength and hardness result from slight increase in the proportion of combined carbon to that in a free state, it follows that strong irons have a greater rate of contraction than those in which a lesser amount is present. When the combined carbon exceeds certain limits, hardness and contraction increase rapidly and the strength decreases. Incresase in the proportion of free carbon has the opposite tendency.

Silicon, when present, not exceeding certain limits, tends to free the carbon, reduces the rate of contraction, and increases the ductility and softness of the iron. Increasing the silicon up to, say ten per cent., causes the iron to become brittle, hard, and weak, and increases contraction.

Sulphur tends to change the carbon into the combined state, and hence increases the rate of contraction.

Phosphorus, while tending to harden the iron, has little, if any, influence upon the proportion of combined to free carbon. It lessens the rate of contraction and diminishes the strength of the iron.

Manganese, as usually present in foundry irons, about 1 per cent. has no appreciable effect. When, however, it reaches 1.5 per cent, and the iron is low in silicon, it tends to hardness and increases contraction, although no alteration in the carbon is affected. In some hard irons the combined carbon is lessened, as also the contraction, by adding small quantities of not exceeding 0.15 per cent. of manganese to the molten iron in the ladles just before pouring in the mold. Increased strength also results.

Repeated melting increases the rate of contraction; it tends

to harden the iron and increases its density. Originally soft mixtures become stronger and harder, while hard mixtures become harder; the proportion of free carbon decreases and the combined increases; the total carbon is slightly decreased. Silicon and manganese rapidly decrease, phosphorus to a less extent, while sulphur rapidly increases, due to the fuel.

At this point Mr. Schumann, who, by the way, has had one of the most extensive experiences in practical foundry affairs, presents some algebraic formulas, supplemented with illustrations of objects treated. The whole shows the great amount of thought the writer has bestowed on this subject, which has yielded fruitful results, as evidenced by the following conclusions:

The deformation of prisms due to unequal contraction can be overcome by providing counter deformation in the pattern, or by the addition of auxiliary parts that can be readily removed from the casting. Generally, the section should be so subdivided or designed that the ratios are alike around the centre of gravity of the section.

In complex machinery castings the design should be so modified or chosen that these will result in the least differences in the rate of cooling, or ratios of the different members. Sudden changes in form cause severe initial stresses, if not fracture, and should be rigidly avoided.

Imperfectly proportioned flanges, ribs, or gussets added to the main body of a casting, for either the purpose of increasing the strength or connections, may be sources of weakness.

Hollow cylindrical columns, although cast of even thickness and left in the mold until cold, may become crooked by reason of the unequal rate of cooling between the upper and lower halves, due to the currents of air passing through the column and clinging to the under side of the upper half after the core arbor is removed, which is usually done shortly after pouring and while the casting is still red hot. This deformation is avoided by stopping the ends with sand immediately after the withdrawal of the core.

Greater attention to the laws of cooling and correct forms and proportions of castings will result in increased strength and economy, besides the avoidance of annoying crooked castings and mysterious breakdowns.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

L. C. Jewett writes a short sketch on "Molding a Rope Sheave with Match Plate." The advantage claimed by Mr. Jewett for such a method is a truer casting, as a heavy pattern can be used, and a perceptible increase in output, owing to the absence of making partings and other time-taking operations on the ordinary three parted job.

Thos. Wathey describes some observations made while visiting Philadelphia, and notes, what he considers, an improved way of making planer platens, wherein the T cores instead of having the usual narrow print are made of sufficient width to cover the whole bottom of mold. This would in many cases prevent the deflects resulting from an ill-prepared bottom, so often found in molds of this character.

The American Machinist representing one of, if not, the greatest factor in modern industrial advancement, the machinist, devotes nearly its whole issue of Dec. 24 to the apprenticeship in American machine shops. In an effort to secure the facts as to the actual state of affairs it addressed a letter of inquiry to 200 of the leading machinery building establishments of the country, to which were received 116 replies. As a large number of these firms operate foundries as well as machine shops, and their practice in one department would naturally reflect on another, we have thought it well to append some of the most salient points advanced. The "American Machinist," in inviting the President of the Iron Molders' Union to state his observations, has shown the broad conception in which it undertook to accomplish this investigation. It says editorially:

In 1893 the "Century Magazine" published a series of articles on Apprenticeship, in which the position taken was that apprenticeship had been practically abandoned; the reason given being that foreigners controlled the trades unions, and that these foreign-

ers (and consequently the trades unions) were opposed to having American boys learn trades.

This view of the matter has become quite prevalent with the general public, who know little or nothing of trades or of trades unions, except by reading of them in newspapers and magazines. It will be seen that of the 116 establishments replying, 85, or something over 73 per cent., take apprentices, and that of these, 79, or over 92 per cent. of those who take them, express themselves as, in greater or less degree, satisfied with the system of apprenticeship.

When we come to methods of handling the matter, we find considerable diversity of practice. Only 47 per cent. of those who take apprentices have any written agreement with them. Those who have such agreement may be disposed to deny that the others have any real apprenticeship system worthy of the name. But the fact is that some of these shops having no written agreement with apprentices, and employing them under a verbal agreement, terminable at the will of either party, do, to our personal knowledge, give thorough instruction in all branches of the trade, so far as it is pursued in their establishments. So far as we are able to discover, the trades unions exert no influence worth speaking of on this question of apprenticeship. Few letters refer to that phase of the subject at all; and practically none say that the apprenticeship system is at all interfered with by trades unions. We have referred to the discussion of this subject by the "Century Magazine." The articles published by this magazine have no doubt done very much to form general public opinion regarding apprenticeship; and, owing to these articles, there are undoubtedly very many who think they know that apprenticeship is entirely abandoned in this country; that it has been abandoned almost solely because the trades unions are controlled by foreigners who do not wish American boys to learn trades; and, finally, that the only hope for the American boy, and for preventing the entire alienation of our mechanical industries, lies in the trade schools, such as were founded by Colonel Auchmuty here in New York. The fact is that the "Century" articles were inspired by the late Colonel Auchmuty, who was an admirable gentleman, but was

an enthusiast on the trade school matter, and probably sincerely believed that all who doubted the fitness of the trade school to completely fill in every respect the gap left by the demise of apprenticeship were wilfully blind, selfishly interested or grossly ignorant. He lived in New York and anyone at all broadly acquainted with trade matters can easily perceive that his ideas were based upon things as he found them here in New York, where the conditions are peculiar and do not by any means represent the entire country in this matter.

This view is strengthend by the circumstance that of those machine shops in New York city answering our letter of inquiry, the majority do not take apprentices at all, and the only prominent shop here which does is that of R. Hoe & Co. None of these seem to consider the influence of trades unions of sufficient importance to refer to.

It is clear from the evidence presented that, to the extent that apprenticeship has been abandoned in our trades, it has been chiefly due to the fact that modern methods of manufacturing machinery do not so well adapt themselves to apprenticeship. But at the same time it is made clear that nothing like a general or complete abandonment of apprenticeship has taken place in machine shops, and that apprentices can be and are taught the trades of machinist, molder, pattern maker, etc., with entire success and satisfaction to all concerned, even in shops where modern methods of working and management have been most highly developed, and we are convinced that in almost any shop where it is possible to learn the trade, it is possible to train apprentices, and can be made advantageous to do so.

In conclusion, we may say that one of the important things clearly shown by our inquiry into the matter is the importance of first taking considerable pains to secure good, honorable, straightforward boys who have a taste for machinery and for mechanical matters, and then so treating these boys as not to lower their self-respect and ambition, but rather to build them up and help them to perceive the fact that there is scarcely any avocation more worthy of the best efforts of the best men.

Abstracts from Letters Received by "American Machinist," Dealing with the Apprenticeship Question.

It is our custom to place two or three of these apprentices under the direct charge of a experienced leader, whose sole duty it is to look after their work, and to see that it is carried out properly and most profitably.

* * *

We were lead to start the apprenticeship system from the fact that we found difficulty in securing good workmen in our particular line, and we were led to think the best way to secure good workmen was to educate them in the different branches of our work, and we are glad to say we have not been disappointed.

* * *

We have very little faith in trade schools producing mechanics who could go into a shop and make a living at the trade they have learned in these schools.

* * *

Our business being strictly manufacturing we believe the best results are obtained by educating special hands for each operation.

* * *

There are no training schools in this vicinity, but we do not see how any such introduction would fit a boy for the workshop. Long-continued contract with the actual operations of a working establishment and personal participation therein are the only means by which the machinist or other mechanic can obtain that dexterity and skill which make him superior to the amateur.

In general, we endeavor to make our works attractive to good workmen, by using good tools, doing good work in a comfortable shop with good sanitary arrangements, by paying liberal wages and affording regular employment. These inducements are quite as attractive to the boys as to the more mature workmen.

Trades unions have never interfered with our system of apprenticeship.

There is no agreement, contract or indenture of any kind in our system and hence no curtailment of freedom of choice and action.

We rely wholly upon the sense of honor of the apprentice in the discharge of his implied obligation to us. In this we have seldom, if ever, been disappointed.

We take apprentices, and believe it is more or less profitable to do so; at any rate, we know of no better method of producing good workmen than by the apprenticeship system.

Regarding the matter of depending upon trade schools for good workmen: We do not believe in the system, as learning a trade is very much like learning a language, and the graduate from a trade school entering a shop, finds himself very much in the same position that a foreigner does who has learned the language abroad.

* * *

We make no promise to learn the boy a trade; if he is bright and ambitious he will learn himself with the opportunities which we are glad to afford him.

* * *

In our opinion one of the reasons why the apprenticeship system has been looked upon by many as unsatisfactory is that there is very little atttention paid by the boy to his obligation, and the company fails to keep the boy at work or to take any special interest in him, but for any pretense whatever lets him go.

A still worse system than this, even, is where no agreement is entered into at all, the boys coming and going as they choose. This seems to us a most demoralizing practice, and it is hardly fair to condemn the apprenticeship system when these loose methods are employed. In fact, it is not an apprenticeship system at all.

While technical schools and manual training schools are of great importance, it seems to us that nothing can take the place of a boy's being indentured to some first-class concern who will take an interest in him, and see that he faithfully fulfils a well-defined term of agreement to which he shall pledge himself.

One of the most important things for a young man in any sphere of life to do is to learn how to work; and the next thing is to do such work in the best possible manner.

* * *

We do not bind any apprentices now. We take boys, and if we find they are all right, we keep them to work by keeping them satisfied as far as pay is concerned.

We have had rather poor luck in binding boys late years, as if the boy is good for anything at all, he is not satisfied to work his three years, as we used to have them, and if he is not good for anything, we are not satisfied and want to get rid of him, so we find it better to select the best boy, and keep him, paying him enough to satisfy him.

* * *

We do take apprentices and find it advantageous to our business. We do not make any agreement or contract with them. Of course, we only keep those who prove, after a trial, to be worth keeping. To the best of our knowledge, we advance the wages of our apprentices faster than is the usual custom where agreements are made and they are taken for a term of years. The reason we have pursued this course is that, there is no method that does not cost more than it comes to to hold an apprentice if he make up his mind to leave at any time he sees fit, while it is a simple matter for the apprentice to hold us to any agreement.

* * *

We have found it desirable to abolish the apprentice system altogether, having experienced, in addition to the objections you mention, that a better class of beginners and more progress can be assured from paying boys what they are worth to us. Under the old system indentures were signed for a period of years and the wages were stated without regard to the apprentice's usefulness or capability, and all were placed on one plane—the effect being to retard the progress of the more apt, rather than encourage the less diligent.

Now we simply employ boys and give them what we find them worth to us. This encourages them to work, and as the wages depend on their efforts and are not confined to the established rates for apprentices, good or bad, we find a better and more intelligent class ready to learn the business.

* * *

In my opinion apprenticeship should not be a thing of the past. I have had some experience, in fact, I might say considerable, as relates to the class of mechanics made under the regular apprentice system and those coming from trade schools, and while I in all cases would prefer to have our apprentices start in

with a good education, and might perhaps say even with a thorough technical education, at the same time I have not found that at the end of the four years of apprenticeship, they rank as superior mechanics as against boys of energy, who would take advantage of opportunities to learn the essential points of technology in connection with their trade.

* * *

Where you have too many boys in the shop and cannot give them all good work, it means dissatisfaction, particularly if some boys are advanced faster than others.

It has been suggested that it is better to give the boy a technical education before he goes into the shop as an apprentice. Think this is entirely wrong; believe he should serve his time and then obtain his education at a technical school afterwards, as he can then see the advantage of an education, together with the knowledge obtained from his service in the shop as an apprentice.

I have known cases where boys have come into the shop after having gone through such schools; the result has been they did not apply themselves to the business and are constantly of the opinion that they should be at the head of the shop in place of at the foot. It is their desire to commence at the top of the business in place of at the bottom.

* * *

I never employ apprentices. You don't catch me trying to teach the trade to any cub who does not want to learn it. If a boy shows an aptitude for the business he has every chance to push himself ahead and, in making promotions, we pay no attention to the barber shop rule of "first come, first served." The smarter boy will get in first every time.

* * *

The trade of iron molding, to which I will more particularly apply my remarks (and here it may be well to interpolate—that branch of it known as machinery and jobbing molding, as being more closely allied to the machine shop than the other branches), either from the inherent difficulty of successfully applying machinery, or the lack of attention bestowed upon the foundry by the inventor, has suffered less in this respect than many others, so that the apprentice question in this trade is free from many of

those complications found in others. But while we have less to complain of from the innovations of machinery, specialization and keen competition have combined to affect injuriously the supply of first-class mechanics. They have developed a habit on the part of the foundryman to treat the apprentice with a view to the monetary end of the transaction, and with but small regard to the interests of the apprentice as a mechanic of the future. To such an alarming extent has this practice prevailed in the foundry, that it is becoming a common saying that a molder must learn his trade after he has served his time; in other words, that he must steal a knowledge of his trade during his subsequent wanderings.

Such a state of things is looked upon by all trade unionists as a distinct but remediable evil, and they maintain and I believe with justification, that the apprentice's rights should be better protected. To accomplish this they advocate the adoption of some binding form of indenture having the force of law, which will guarantee to the apprentice, on the one hand, adequate opportunity, for a specified number of years, to acquire a thorough knowledge of his trade, and will insure to the employer, on the other, continuity and fidelity of service. Such a system faithfully followed out by employers and supported by the trades union, would effect a very material improvement in the skill of the American mechanic, when compared with the product of the present unsystematic and slipshod method. Any movement in this direction, I feel assured, would command the hearty co-operation of trade unionists.

MARTIN FOX.

* * *

In conclusion, I would like to say that it has been my experience on numerous occasions, when called in my official capacity to adjust grievances arising from the wage question, to be told by employers that they would have no hesitancy in paying more wages if the men were worth it, but they were, as a rule, a lot of incompetents. To test their sincerity, I have suggested to them that the only true way of getting competency was in the limiting of the number of apprentices, and particularly in their training. Except in rare instances, my suggestions were met with anything but appreciation. So until they show a disposition to assist in

training mechanics as they ought to be trained, I am forced to the conclusion that their cry of non-competency is only an excuse for their not paying the "hire of the laborer."

JAS. O'CONNELL,
Grand Master Machinist.

THE AMERICAN MANUFACTURER

In discussing the alleged defection in plates furnished by the Carnegie Steel Company, says:

The report of the board appointed to investigate the alleged defective hull plates furnished by the Carnegie Steel Company to the Newport News Shipbuilding Company has not yet been made public, but sufficient is known to show that the fault did not lie with the makers of the plate. It seems that there was an error and that error was such as could easily be made by anyone not thoroughly posted on the manufacture of steel. Among engineers nowadays it is the rule to require great tensile strength in steel material. Years ago 50,000 pounds tensile strain was considered a very satisfactory test, and steel of that composition could be bent and twisted in any way. But now specifications will call for a tensile strength of 70,000 pounds, forgetful of the fact that to get this more carbon must be added, and that tensile strength is secured at the expense of ductility.

This was exactly the case in the plates about which so much has been published. Each and every one of those plates were made according to specifications, and all stood the government test. They were exactly of the quality and composition ordered. But when finished, they were put to a use which had not been taken into account when ther chemical composition was decided upon. In other words, ductility had been sacrificed to get a high tensile strength, and the result was that the plates could not be bent in the manner required. At the same time, the inspector's stamp on each plate showed that they were up to the specifications and contract requirements. This relieved the Carnegie Company of all responsibility, and as the shipbuilding company accepted the plates on the stamp of the inspector, it certainly seems that both concerns complied with all regulations. But the plates, for the

reason stated, were not what was needed, hence the alleged failure. The worst feature is that in such cases the failure is given the widest publicity, without the reasons or the most important facts.

COMPRESSED AIR

Has an illustrated article by Ralph H. Sweetser on the air plant connected with Furnace "A," of the Maryland Steel Co., at Sparrows' Point, Md. It describes some of the advantages that air has over other motive powers around blast furnaces, some of which are also proving themselves of high value in foundries.

CHICAGO JOURNAL OF COMMERCE

Gives some illustrations of large castings turned out by the Sargent Co., of Chicago. These include a set of gear wheels weighing forty tons and a breeches pipe lately cast for the Pioneer Power Company, at Ogden, Utah.

DIXIE.

Wm. H. Brewer writes of "The Southern Coke Industry," tracing its development from its infancy to the present mammoth production. After treating of the more recent improvements, the saving of by-products is taken up and a horoscope cast of future methods that will become necessary with the introduction of the steel industry.

THE ENGINEERING MAGAZINE

"The Cost of Iron as Related to Industrial Enterprises," by George H. Hull, forms a subject that will commend itself to the student of current problems. If the discussion of such a semi-economical question can bring about a greater stability in values there can be no doubt of this acting as an impetus to further and more permanent activity. Mr. Hull writes:

The steadying effect of an ample, visible supply of any staple article of manufacture is apparent, but the importance of this in the case of pig iron is far from being appreciated. In fact there is in the United States no great staple article that is allowed to drift so helplessly in the storms and sunshine of trade as this important product.

It is generally admitted that no manufacturing business can be safely carried on, or made reasonably continuous and profitable, if it depends upon a raw material that is subject to great fluctuations in price. Iron enters more generally into all the great enterprises and improvements of this age than any other staple. It is, therefore, of the first importance that the fluctuations in its price should be confined within reasonable limits; otherwise the business of the whole country must be disturbed, when these excessive fluctuations occur.

To ralize how important the price of pig iron is to a long continuance of the prosperous condition of general business, we have only to consider the universality of its use, and to examine the effect its fluctuations have had on the business of this country in the last fifty years.

The history of pig iron in the United States is a succession of periods embracing a quick and enormous advance in price, followed by a quick and enormous decline, resulting in several years of depression and unremunerative prices. These abnormal advances have been caused in every instance by the small surplus stocks carried in the United States, and the struggle of each manufacturer to obtain enough to supply his needs at each recurrence of a general revival of business.

It was the revival in business and small stocks in 1854 which carried iron from nineteen dollars to fifty dollars. Everything was prosperous, but fifty dollar iron put a stop to many of the great enterprises; thousands of men were thrown out of employment all over the country; the new furnaces built on high prices came into blast, prices commenced to tumble, and the great panic of 1857 resulted; the price of iron had fallen to twenty-seven dollars —but it did not stop there; it continued to fall, until it reached eighteen dollars in 1862. The five years of depression ruined furnacemen right and left, and many of their plants fell into decay.

Stocks were again at a low ebb when the revival of business in 1863 put iron on the up-grade again; there was an actual famine in iron. Prices jumped several times, as much as five dollars per ton in a single day; but even fifty-dollar iron could not stop the

prosecution of the war and its attendant necessities, and iron during the following year reached eighty dollars per ton in the middle states and seventy-four dollars per ton in the east.

After the great war consumption ceased, iron dropped to thirty-five dollars in 1870, but the increased demand of 1872 put the price up to sixty dollars in the middle states; again the great enterprises were stopped by the high prices, and the panic of 1873 soon followed. Within the first year of the panic it dropped to thirty-five dollars, which was less than actual cost in the middle states, labor and all raw materials entering into its production having advanced so largely in 1872; but it did not stop at thirty-five dollars. It continued to drop, until it reached twenty dollars in 1879, and in these six years it was produced at a constant loss, as the decline in the price of iron always precedes, by a long period, the reduction in the cost of its manufacture. Again, in 1880 the small stock and renewed business carried iron to forty-five dollars.

Will anyone claim that these enormous advances were not important factors in stopping the building of railroads and other large enterprises in each of the periods named, or that the discharge from employment of many thousands of workmen, which this stoppage occasioned, was not the beginning of the panics that followed?

No other great staple is subject to these enormous fluctuations, for the reason that larger stocks of the other staples are carried; but just in proportion as you stop the consumption of lumber most other great commodities is checked.

It must, therefore, be admitted that a large accumulation of surplus pig iron in seasons of dullness is the only condition that would prevent these enormous advances in price when prosperous business periods return; but the question is: how can these large surplus stocks be accumulated and carried without injury to the furnace business?

Experience proves also that consumers of pig iron rarely carry a combined stock exceeding two or three weeks' production, and that the accumulation of even one additional week's production will carry prices down unreasonably. Manufacturers make their

iron to sell; if they cannot get one price, they will usually take a lower. Some of them have money enough to accumulate iron; others have not. The poorer furnaces which are compelled to sell, lead the decline, and the rich ones must accept the price made by the poor ones.

Experience proves also that consumers of pig iron will not carry large stocks. Among the few that have surplus money in their business, some addition is made to stocks when prices are going up; but, in the several years that prices are going down, consumers generally buy to supply only their immediate wants, and at no time is their stock so light as at the end of several years of depression.

As a broad principle, then, large surplus stocks of pig iron will not be carried by either the manufacturer or the consumer. It will be done only by some middle element, as is the case with other great staples.

In the case of general articles of trade, like dry-goods and groceries, it is done by the jobber and retailer; this we will designate as "natural carriage." In the case of large staples, like cotton, grain, petroleum, provisions, and pig iron, it can be done only by storing the article itself, issuing a negotiable certificate against it, and bringing about general dealing in these certificates on exchanges; this we will designate as "certificate carriage," or "warrant system."

Every great staple except pig iron has had this "certificate carriage" established for it in this country. In the case of each of these staples the majority of the producers at the start have been unfavorable to the introduction of that particular commodity on exchanges. They reason that, if the small "natural carriage" of surplus stocks depressed prices, a large "certificate carriage" would depress prices more violently still. They reasoned, that the fluctuation in that article would be increased by its introduction to exchanges.

A careful examination into the history of every staple article that has been introduced by certificates to exchange dealings proves that both of these theories are unfounded. On the other

hand, an exhaustive examination shows that the extreme fluctuations have ceased, in the case of each of the staple articles, after the introduction of that article to exchange dealings. We will give but one illustration.

Petroleum, before it was introduced on exchanges, showed violent fluctuations for nine years, ranging from fifty-two cents to seven dollars and eighty-eight cents per barrel at the well. A surplus stock of a half million barrels carried the price down to fifty-two cents. The extreme fluctuation for nine years after it was introduced to exchanges was from sixty-four cents to one dollar and six cents, and a surplus stock of thirty-six million barrels carried the price down only to sixty-four cents. Every great staple that has been introduced to exchange dealings in this country has experienced like results, the producers of these articles, as well as the consumers, realizing a steadying effect not experienced before.

Just in proportion as pig iron enters into the general business of this country will the general business of the country be benefited by the introduction of a system that would curtail the violent fluctuations in its price.

It is believed by some that this "warrant system" will not absorb large stocks of pig iron, and they cite the fact that even moderate lots of 10,000 or 20,000 tons of speculative pig iron, such as have been carried during various times in the last twenty years, have always depressed the price; but they lose sight of the fact that these speculative lots have been carried by unnegotiable storage receipts, and such carriage has always been, and always will be, harmful to the iron trade. There is, however, between this carriage and the carriage by a negotiable certificate dealt in on exchanges the widest difference.

This "warrant system" has existed in Scotland for over fifty years, and for thirty years out of this time surplus stocks of pig iron in Scotland had been equal to from six to twelve months' production. During one period the stock for five years in succession succeeded a year's production.

What better assurance can there be of the benefit of this system than its fifty years' history in Scotland? That market has

not been subject to the violent fluctuations which have occurred in the United States, and the manufacture of iron in that country has been more uniformly profitable.

Many believe that the investing and speculative public will not absorb a large stock of pig iron through exchange dealings, but there is no real foundation for this doubt. The public will not carry unnegotiable storage receipts, just as the public would not carry petroleum stocks until they were put in proper shape; but, as soon as these stocks were represented by exchange certificates, the public quickly absorbed 36,000,000 barrels, and carried it without any depressing effect, and that same public will carry all the surplus pig iron that can be accumulated in this country under the "warrant system."

More than one-fifth of the entire wealth of the United States to-day is invested in the carriage of property represented by certificates. The addition of stocks, bonds, and certificates on the New York Exchange alone averages about $400,000,000 per annum. It is really the only shape into which property is put in which the money may be said to seek the property. There is no reason to doubt that this class of money-owners will absorb all the surplus cotton, grain, petroleum, provisions, etc. The actual expense of carriage to the investor, on pig iron, is about one-fourth what it is on all these other great staples. It is this feature that has tended largely to make pig iron warrants the favorite speculative commodity in Great Britain for many years.

We have had no such violent fluctuations in price of iron during the last ten years as we had during the thirty previous, for the reason that we have had no such violent and long continued panics, and the cost of iron is permanently lower; but the moderate revival of business in 1889 and 1895 caused an advance of 75 to 80 per cent., and these ruinous fluctuations will continue until large surplus stocks are carried.

The "warrant carriage" not only is a benefit to the trade during seasons of depression—by absorbing the surplus as it is made, thus enabling the furnaces to continue in blast, without overloading and depressing the consumers' market, whereas, without this

system, the furnaces go out of blast in about the proportion that the consumers cease to buy. We have had an illustration of this during the last few months.

In the Shenango and Mahoning valley, where the "warrant system" had not been adopted, there were, in January, twenty-two furnaces in blast, nineteen of which had gone out of blast by August 15. In the Alabama and Tennessee district, where the "warrant system" had been adopted by most of the furnace companies there were, in January, thirty-two furnaces in blast, only seven of which had gone out of blast by August 15. In fact, every furnace company in the southern district which had adopted the system was not only able to keep its furnaces in blast at the time of greatest depression, but was able to sell, through exchange warrants, all its surplus stock at satisfactory prices.

An effort to force of 10,000 tons in the first named district during the depression in August resulted in only a small sale, at $1.50 per ton below quotations, whereas, in the southern district, where the system had been adopted, 50,000 tons were easily sold by warrant, at the same time on a concession of ten cents per ton, followed by a sale of another 50,000 tons at a substantial advance.

The conditions in these two districts were very different, but this does not affect the point we wish to illustrate—namely, that the previous introduction of the "warrant system" in the south had created a trade for southern warrants which quickly absorbed all the surplus iron as soon as the demand from the consumers ceased, a condition wholly lacking in the valley district.

A prominent iron master of Great Britain recently said, in reply to a question as to the usefulness of the "warrant system" to producers and consumers in Great Britain:

"They simply could not get along without it. It is a necessary adjunct to the iron business. Consumers and dealers who desired to make prices on large lots of manufactured iron and steel for long future delivery would be obliged to take a large risk of the market, if it was not for the "warrant system." As it is, they can always protect themselves on these bids by purchases of warrants. Then from the producer's point. Furnace companies having on

their yards a large stock of iron, or a large stock of raw material, if they anticipate a decline in the market, can telegraph to Glasgow and sell 10,000 to 20,000 tons by warrants within a few minutes, without affecting the price more than one or two pennies, whereas, if they attempted to sell a like amount of iron to consumers, they might be a week in doing it, and would depress the consumers' market as many shillings, as they would pence by selling on the warrant market."

The general adoption of exchange dealings in pig iron would enable the producers to market all their surplus product in times of depression, without undue lowering of prices.

The accumulation of large surplus stocks through this means would not prevent a reasonable advance in prices in seasons of large demand, but would prevent the enormous advances which quickly hamper and eventually paralyze great enterprises.

"Stability of value is the safeguard of the producer and consumer alike."

THE FOUNDRY

There are several branches of the foundry trade that remain practically unknown to the majority of those engaged in molding and casting. One of the most notable and at the same time one of the most interesting branches of the founder's art has practically remained obscured to view. We refer to the "Founding of Statuary," for the enlightenment of which Horace G. Belcher contributes a lengthy article with ten illustrations to the December Foundry, in which he deals largely with practice and details in vogue at the statue foundry of the Gorham Mfg. Co., at Providence, R. I.

In his introductory remarks Mr. Belcher says:

There is something inspiring in a mass of metal wrought into the form of living beings. And if to this form is added such apparent action as to cause us to doubt its creation by man, we can readily see why such work commands attention. We admire a piece of machinery for its strength, we are awed by its power. We look at a large bell or other great casting and we are impressed with its mass. We turn our eyes towards a statue and

power, mass and material is forsaken. We judge this kind of work by a different standard, and rate its greatness according to the amount of life the makers have been able to infuse in it. The greatest statue is not the largest, but the one that is truest to life.

Bronze founding, as a fine art in this country, is at the commencement of a new era. The artistic sense and taste which fills the cities of the old world with masterpieces of the greatest sculptors and workers in imperishable bronze, has, here, until the last decade, been subordinated, and made secondary to the commercial spirit of trade, although many bronzes, of artistic merit and worth, prove the native ability. Of late years there has been a revival of this ancient art, which antedates the earliest written records of history, and increasing recognition of the value of American work. It is no longer necessary to send models to Europe for fine castings, as work equal to the best produced in the old world, is made here, in foundries established within comparatively few years.

The article, after describing the foundry, core ovens, and furnaces, concludes with an account of the casting of one of the best known pieces of statuary, the silver statue of Columbus which formed one of the chief attractions in the Gorham Mfg. Co.'s exhibit at the World's Columbian Exposition.

S. S. Knight, in writing of "Carbon in Iron," gives out some verified statements that must result in changing a few theories to which we have so far clung tenaciously. The following is part of the paper:

The only explanation that I have ever read as to why iron should contain carbon was based upon the fact that all carbon is combined when the iron is melted in the cupola or furnace, and that it was thrown out in part in the form of graphite, as water throws out its impurities in part when it crystallizes.

In order to have crystallization of any kind, some time must be allowed for the molecules to arrange themselves. Quartz crystals can only be produced by allowing the silica to deposit slowly. So in iron, the slower the cooling the more crystalline the form. Now if graphitic carbon can only exist in iron that has

crystallized, it remains but to cool the metal rapidly and all the carbon will necessarily remain combined. In order to test this, iron was taken from the cupola and poured through a riddle into ice water, thus allowing no change for crystallization. The shot thus formed were disintegrated and analyzed, and free carbon found. The amount of combined carbon was slightly above what it was when allowed to cool slowly, but that was due to the interference with any possible reduction that might have occurred by such gases as carbon monoxide which escaped from the sand through the iron. Hence the theory that all carbon is combined in molten metal is wholly untenable.

The question as to whether it was possible to increase the amount of graphitic carbon in any iron has often been asked the author. The reason why this question is so predominate is undoubtedly because foundrymen have looked toward an excess of silicon and graphitic carbon as the Elysium of their hopes. The silicon had only to be put in, but the graphite—they did not know.

The old theory of carbon in molten iron faced them, and many that would have investigated gave hopelessly up when they found their ignorance was so common.

In fact, the whole question of definite result from definite causes in the mixture of iron seemed to be universally conceded beyond the limits of human understanding, and so the most of those who should have known when asked gave a wise smile and toss of the head, and replied that it took time to conquer such deep and abstruse subjects. They frankly admitted that they did not know, and those that even attempted an explanation were soon so befogged with their own inconsistencies that they gave up. All were too busy to investigate, and the few that did have theories had never put them to test.

Under these conditions a series of experiments were started. Results were closely observed and analyzed, and now it stands ready for verification by all who wish to prove to their own satisfaction that the only two requirements for the formation of graphite in iron are a low temperature of the molten metal and much carbon to flow over. The only thing that hinders hard iron

from taking graphite is that too high a heat is required to melt it, and hence hard iron cannot be softened that way. The more silicon in iron the lower its melting point; hence the increase of silicon usually means increase of graphite carbon.

"The Manufacture of Charcoal" is completely illustrated by L. S. Brown, who leaves us a great deal of information on this subject, describing in detail the process from start to finish and the effects certain variations have on the quality of the product.

From the pen of Jas. A. Beckett comes a letter on "Physical Tests of Cast Iron in the Foundry," from which we take these quotations:

Considerable heat has been developed in the past discussion of the test bar question, but if the time ever comes when it can be discussed in a temperate and purely disinterested manner, I think that it will result in the adoption of the inch square bar, broken at twelve inches between supports, as the standard for measuring the transverse strength of cast iron for ordinary foundry purposes. While there are some objections to the adoption of this size of test bar, there are many things to be said in its favor. The square inch is the unit of area or volume of iron, of which the transverse strength is required. Therefore a square inch should be the area of the bar tested, as it is a well-known fact that when using a smaller bar or a larger one, in order to get the true value of the result obtained per square inch, correction tables have to be used, which are not easily understood by those who usually have the matter in charge. The grain in the fracture of the inch square bar is more nearly the same size as the grain in the fracture of medium-sized castings, especially in those portions of the casting which are depended upon for strength. The principal reason for breaking the inch square bar at twelve inches will be found in the fact that the result obtained at twelve inches is more nearly a multiple of the tensile strength of a square inch of the same iron in the specimens now commonly used to obtain the tensile strength of cast iron. These specimens are usually round and the area equal to a square inch when they are poured from the same ladle as the inch square bar. The operator of the testing

machine cannot fail to be struck with the regularity with which the transverse strength of the inch square bar broken at twelve inches proves to be one-tenth of the tensile strength of the other specimen, which is the equivalent of a square inch cast in the same mold. The proportions are not absolutely constant, but the variation is so slight that it is hardly worth taking into account, when we consider the variations which at present seem to be a necessary element in any test of the strength of cast iron. While there is some doubt as to the utility of making tests of the tensile strength of cast iron, it has not affected the demand for such knowledge on the part of engineers and others who are users of castings. Such being the case, the above form of transverse test gives the average foundryman, who is unable to buy an expensive machine to make tests of tensile strength, a means of ascertaining the tensile strength of his product with a fair degree of accuracy—in fact, near enough for all practical purposes—by the use of a machine that is so cheap as to be within the reach of any foundry, however small.

W. L. Hayden completes the first installment of a series of three on the "Down Draft Core Oven," taking up as a beginning the details above ground. The whole is profusely illustrated from working drawings.

Henry Hansen, in "Some Pencil Sketches of Failures," addresses some pertinent remarks, particularly directed at foremen and molders, against some practices that are tolerated, more on account of long usage than anything else.

L. C. Jewett tackles the subject of venting and reaches the conclusion that instead of avoiding ~~this~~ we are often doing our best to produce it.

W. J. Keep, in "Cast Iron Notes," answers several questions of a typical nature, relating to coke and iron. Among the questions answered is "How to reduce the shrinkage of castings; poor coke and silvery iron," to which the following reply is made:

It is not the sulphur alone that produces the breakage. It is a good rule to purchase for thin castings southern iron made from all red ore, as this generally has less tendency to chill, but some

southern brown ores will make non-chilling iron. There is no need of buying high-priced silicon iron. Purchase No. 1 or 2 soft southern instead of No. 2. With your thin castings you should keep the silicon about 3 per cent. or even higher and then you would not notice any slight change in coke. Your trouble comes more from irregularity in your pig iron than from your coke. Instead of three brands you should use five or six brands so that any chance variation in any one will not affect your castings.

Some queries relating to "Smoky and glistening coke" are dealt with and "A mistaken idea regarding cast iron" corrected.

THE IRON AGE

Illustrates a difficult pump casting weighing 48,300 pounds, made in the foundry of Robt. Poole & Son Company, of Baltimore, Md.

In speaking of "Problems in the Steel Industry," the Iron Age says: The one absorbing question before every manufacturer of iron and steel in the United States must be that of cutting down costs of production. It is pretty well understood in the industry that conditions must be met which few until recently ever dreamt of encountering. The majority of those who felt complacently secure in their position as to competition with rivals in their own or neighboring districts must face a new situation. We are being steadily forced to a lower level of prices. For a time associations or pools may hold up values, but the irresistible tendency is downward. In fact, it is becoming a well recognized principle that the peace during times of artificial prices must be utilized to prepare for the inevitable war on prices. The manufacturer who does not freely spend money earned while prices are good for improvements which keep him in the front rank will find himself among the vanquished. The status of a producer is determined by his capacity to inflict injury upon others. That capacity is measured by his cost of production, and by his determination and his ability to suffer a sharp loss when the days of fighting have come. Dozens of old-fashioned plants, which only occasional booms call

into temporary activity, tell the story of neglected opportunities and failing courage.

A. J. Rossi presents an article on the "Constitution and Properties of Cast Iron," taken from a paper by A. Pourcel, in the Revue des Sciences. In treating of carbon, Mr. Pourcel says: In short, cast iron is not a definite compound, and carbon can dissolve in molten iron in quantities varying with the temperature. Furthermore, it is a well-known fact that if pure iron and carbon in excess are melted at a temperature of 1,500 degrees Celsius and cast in thin plates (15 mm.) in a metal mold, where the solidification of the molten mass is rapid, against the faces and bottom of the mold, a white pig iron is obtained, while the upper part is gray. Still the amount of total carbon in both parts will prove to be the same. It is not, then, the amount of carbon which these two metals contain which gives them their peculiar appearance and physical properties, but the state in which the carbon exists in them. It is not only the quantity of total carbon which a pig metal may contain which has an influence on its physical and mechanical properties, but also the form in which this carbon exists. For the same amount of total carbon contained in two pig metals, one white the other gray, the specific gravity is invariably smaller for the latter, while the melting point is higher by fully 100 degrees C. than that of the white iron. Furthermore, the most fusible of the two pig metals containing the same amount of carbon is the one in which the combined carbon predominates—that is, the hardening carbon and the carbide carbon. Graphitic carbon is carbon set free when the molten metal solidifies. In order to be resolved this carbon has to absorb the same quantity of heat that it has disengaged by its separation.

IRON TRADE REVIEW.

The Iron Trade Review reprinted an article from the "Locomotive," in which the author wrote disparagingly of cast iron as a material for steam pipes, and ended by declaring it unfit for such purposes. The Addyston Pipe & Steel Co., of Cincinnati, in commenting thereon, advance some reasons that ought to coun-

teract any wrong impressions as to the utility of cast iron in this place. They say:

"The article gives an example of a cast iron steam pipe bursting, then describes the way the pipe was made, and ends up with the conclusion that cast iron should not be used for steam pipes. The glaring inaccuracy and injustice of this conclusion is easily apparent to any one who has investigated the manufacture of cast iron pipe. In the first place, the failure of this pipe simply shows that cast iron pipe should not be made on side, a claim which has been made by all the reputable foundries for years. The description of the manufacture of the pipe as given in the article, shows that the pipe in question was cast on side, and that the core floated up in the middle, as might be expected when pipe are so made, and this made the pipe one-sided. None of the modern pipe foundries make pipe in this way. The pipe are all cast in iron molds placed vertically in pits. The mold is made of dry sand. The core is not 'coated with a composition of flour, coarse sand and molasses.' It is made on a stiff core bar, covered with hay rope and two coatings of loam. It is then dried, and afterwards covered with facing. This core is then placed vertically in the flask, and held in position firmly at top and bottom by machine tools which will not allow it to shift its position in any way. It is not possible for the middle of the core to be 'buoyed up,' as the core stands vertically. Furthermore, every piece of pipe cast in the best foundries is tested to a hydrostatic pressure of from 250 to 400 pounds per square inch (according to the service for which the pipe is intended), and rapped with a hammer while under pressure. If any piece does not successfully withstand this test it is broken up. We have manufactured a great quantity of pipe for steam purposes, and have never had any trouble as described in your article; nor have we heard of such trouble with the pipe of any other reputable manufacturer. We have not heard of a case of a cast iron steam pipe bursting under pressure.

"As stated before, the article simply proves the claim of the large pipe foundries, that pipe should not be cast on side, and the

attempt to construe this failure as an argument against cast iron pipe in general, is unjust, especially as cast iron pipe is now used very generally in large steam plants."

IRON MOLDERS' JOURNAL.

F. Lakin describes the making of large pans in green sand and gives a well written exposition of some of the possibilities in this material.

MACHINERY

Devotes an exceptionally large part of its December issue to matters pertaining to the foundry. W. J. Keep takes up "Improvements in the Foundry," and in doing so gives voice to several plain truths from which the following is deducted:

"The mixing and melting of iron is usually in the hands of a so-called professional melter, who is often the only person in the foundry who knows how to prepare the cupola or how to charge the materials. It is sometimes questionable whether the proportions of iron and fuel used are reported correctly, and often it will be found that they are not weighed at all.

"The melter is often obliged to use irons which are purchased by some one who knows very little about their nature, and perhaps he does not know what is needed if his advice is asked.

"It will often be found that the buyer of the iron, the melter, the foundry foreman, the superintendent and the proprietor know very little about the properties of cast iron, but they imagine that sulphur or phosphorus in the iron or coke is responsible for much of the trouble encountered, and that there is something very mysterious about it all and that the subject is beyond their comprehension. They may have had analyses made, and may have sent back some brands of iron that they were sure had caused trouble, but they seem no wiser for the experience. Strength is a property wholly dependent upon the size of the grains and the manner in which they interlock, therefore a different proportion of irons without varying the shrinkage of the test bar, will increase strength. Close grained pig iron or scrap will produce closer grained castings than pig iron with an open grain. The shrink-

age of a test bar will give you more practical information than can be obtained from any chemical analysis."

Geo. O. Vair has an illustrated article on "Molding Press Rolls in Dry Sand," a careful perusal of which should prove of advantage to foundries engaged on this class of work.

"A Bit of Foundry Experience" comes from the pen of L. C. Jewett and is written with the intention of showing the importance that small parts play in every day work. The earlier part of foundry literature generally treated on large work to the exclusion of the many smaller objects that have to be overcome. The example chosen by Mr. Jewett for illustrating his article is one of the many important, though unobtrusive, features that line the path of the foundrymen.

Peter J. Connor in "Notes on Foundry Practice," says:

"The relation which the foundry bears to the machine shop is such that the quality of the products of the foundry have a very important bearing upon the amount of work turned out of the shop. The class of castings required by one concern may be of a kind that would not be of service to another, and the mixtures employed must be determined by those who have knowledge of the wants of the users of them. Many shops have their castings made by jobbing foundries, for various reasons; some because they do not use enough to justify them in running their own foundry, while those located in the large cities may do so on account of the cost of ground room. When the castings are procured from outside parties it relieves the concern of the responsibility of the foundry branch of the business, and they can generally procure such grades of castings as they desire.

"Where the works are large there must of necessity be considerable attention paid to the system of keeping account of weights of castings, prices paid for making them, and records as to when they are finished or under way.

"The Niles Tool Works Co., Hamilton, Ohio, have a separate office department for this purpose; the lists of castings are made up in the drafting room and sent to the time-keeper's (or cost accountant's) office, there to be entered in the foundry order book,

and all records concerning the castings until they are delivered to the machine shop are kept in the foundry office books.

"If for any cause it may be necessary on account of defects to duplicate a casting, an order is made out stating the causes for such action, and if changes in the pattern are required they are made at once."

H. M. Norris writes on "Foundry Cost Keeping." This subject has been very prominent before the foundrymen during the last few months, and a great number of individual systems have been advanced to show actual practice. We reproduce the greatest part of Mr. Norris' paper, as an addition to previous contributions on this question:

Can we afford to take the work at that price? Are we paying running expenses? Is the foreman as good a man as the old one? Is he saving us any money? Why can't we compete with Jones? These are only a few of the questions that present themselves for solution in and about a foundry; but how many superintendents and managers are there who can answer them with any degree of accuracy. Four words, "Look at the books," should be, and is, a sufficient reply to such inquiries in all well regulated foundries; but alas, these are few and far between.

System is just as essential to a foundry as it is to any other branch of manufacture, and should receive the same amount of attention; the results derived from the workings of a good system invariably paying high interest, and are well worth the time and thought spent in getting it up. When the foreman knows that the results of his labor are being watched at the office, and that any saving on his part will be seen and appreciated by his employers, he has a much greater incentive to follow up his men; he will take more pride in the work, strive harder to keep down expenses, and strain every nerve to make each month's report show up better than the last. In fact, system, while perhaps not the life of trade, may be said to be the frame-work upon which trade depends for its support, and it is the key to the success of large undertakings of all kinds.

A jobbing foundry, running on a great variety of work, requires a more elaborate system than one connected with a manu-

facturing establishment in which they only do one class of work. But the information sought is identical in either case; hence the cost at which this information may be obtained is the measure of value of any system.

In foundries where the work is fairly uniform, a form of daily report, such as shown in Fig. 1, may be used to good advantage. Items marked with an asterisk (*) are filled out by the foreman, or his clerk, each morning for the day preceding, when the report is sent to the office and the cost of the iron, fuel and wages are figured from the books.

At the end of each month the results are averaged and entered upon the form shown in Fig. 2, which is sufficiently clear to require no further explanation.

DAILY FOUNDRY REPORT—CUPOLA NO. 2.

Fig. 1. September 19, 1896.

Statement of one day's heat.	Grade.	Weight.	@	Dollars.	Cents.
Pig iron, Rome	2	1500*	.755	11	33
" " Hector	2	3500*	.591	20	68
" " Dora	2	7500*	.531	39	82
" " Alice	2	7500*	.518	38	85
Scrap Iron		13000*	.402	52	26
Sprues, &c		5500*	.550	30	25
Total weight of charge		38500	....	..	..
Coal		......	....	..	..
Coke		3612*	.213	7	69
Wood		283*	.055	..	16
Day worker's time, cost		......	....	75	32
Piece work, cost		......	....	17	04
General expense, including sand, rent, &c.		......	....	45	00
Total		......	....	338	40
Less for Sprues, Pig Bed and Bad Castings		3118*	.550	17	15
Grand Total		......	....	321	25

Total weight of perfect Castings	33,979* lbs.	Cost per lb.	.0094
Loss in Melting	1,403 lbs.	Number of Furnacemen	4*
Pressure of Blast	.... oz.	Number of Carpenters and Helpers	1*
Number of Molders	21*	Number of Boys	6*
Number of Laborers	14*		
Number of Coremakers	3*		

Remarks ....

E. O. SMITH, Foreman.

MONTHLY FOUNDRY REPORT.

Fig. 2.

Classification of Items.	Sept.
Average number of Molders (men)	25.30
" " " " (boys)	6.60
" " " Coremakers	3.13
" " " Furnacemen	4.
" " " Laborers and Chippers	21.56
" " " Carpenters and Helpers	1.
" Pressure of Blast	....
Total number of Hands	62.60
" " " Heats	23.
" " " lbs. Melted	747300.
" " " lbs. Good Castings	654443.
" " " lbs. loss in Melting	25264.
" " " lbs. Melted per lb. of Coke	10.13
" Cost of running Foundry	$6627.38
Per cent of Coremakers to Molders	.098
" " " Laborers and Chippers to Molders	.675
" " " Good Castings per lbs. melted	.875
" " " Loss to pounds melted	.033
Number of lbs. Good Castings per Heat per Man	454.
Cost of Good Castings per pound	$0.0103

Theo. F. Scheffler, Jr., writes as follows of "Foundry Traveling Cranes:"

For the best results in a foundry, there should be no columns between building walls. The traveling crane should occupy the entire span and not be supported by the roof in any way, which is a great mistake, and is not safe for the workmen working below the crane. This of course necessitates a very large crane to do the same work that a smaller crane can do with one-half the span, but the greater span will be an object and will lessen the liability to accidents materially. The writer knows of a case where the workmen are in constant danger, especially when any very heavy casting is to be made. The traveling crane is supported on one side by the building wall, columns are bolted in place against the wall, and the end of column rests in a cast iron plate and the plate on a proper foundation. This part of the arrangement is

all right, but how about the other end of the crane? The other end of the crane hangs from the roof truss, hangers are placed one on each truss, and then I beams are bolted to the hangers and the rails on top of the beams, in the usual manner. The part of the arrangement that the writer finds fault with, is that originally the roof truss was not intended to carry the load placed upon them by half the weight of crane, rails and beams, to say nothing of the load, which amounts to considerable at times, as there are two traveling cranes running constantly. The roof will sag at times all of six inches when the cranes have a very heavy load to carry. The span of these cranes is about 35 feet, and to have a crane that would span the entire building would require one about 70 feet. But this span nowadays is nothing, and it would certainly pay the owners to have one placed in the foundry, so that the men could work with a greater degree of safety.

Robt. Grimshaw presents a sample of German core making machinery, capable of making cylindrical cores up to 12 inches in length and of the same diameter, such as are ordinarily known as stock cores among American foundries.

THE TRADESMAN.

We reproduce the following item on "Annealing Ovens:"

The ovens used for annealing malleable iron at the present time are very different from those of thirty years ago. Indeed, the last ten years has seen a great modification of the soft coal-burning oven.

The oven of thirty years ago employed anthracite coal, the furnaces being located in one corner of the oven, being simply a right-angled fire-brick wall rising to within fifteen inches, more or less, of the arched roof, and being provided with suitable grate and ash pit. The heat passed over this wall, circulated about the pots throughout the oven, and down under the floor by way of holes through the floor, carefully located with a view of even distribution of heat in all parts of the oven. Later the soft coal ovens came into general use. These were always, properly, built in pairs, the reason for which will appear in the following description:

The ovens stood side by side, having a roomy fire-place on the outside of each, extending the full length of the oven, with a door at each end for convenience in firing. From the outer walls of the fire places an arched roof was thrown over to the center walls which separated the two ovens, and within which were enclosed numerous flues extending down and connecting with the flues under the floor. From the inner walls of the fire places (the same constituting the outer walls of the ovens proper) another arched roof was thrown over to the center walls. Thus the fire, smoke and gases were completely shut out from the oven, passing as they did from the furnaces up over the ovens, between the two arched copings, and down the flues enclosed in the center wall, between the ovens, and through the labyrinth of flues under the oven floors, out to the stack. But a still further modification has superseded this style of oven.

When the above described ovens were first designed it was supposed that contact of the gases from bituminous coal would injure the castings. But in the ovens used at present the inner arched coping is omitted, and the heated gases pass over the furnace walls directly into the ovens and out through openings in the very bottom of the center wall, thence through the sub-oven flues which, in all cases, conduct the gases back and forth the full length of the oven several times, thence out through a large flue to the stack.

I do not think that this latest style of oven is anybody's invention. It is probably simply the result of accident. The old double-arched ovens were very difficult things to keep in repair. The inner arches being entirely enclosed would become so excessively hot as to cause them to sag and crack sufficiently to let into the oven some of the gases; and now and then a great rent or total collapse of the inner arch would happen in the middle of the period of firing; and, as no bad results appeared in the product, some thoughtful, courageous manufacturer took the bold step of tearing out the inner arch and doing away with it entirely. This was a great step forward in the process of annealing malleable iron, because it greatly simplified the flue system and reduced the amout of fuel required. For, in the double-arched

ovens, the annealing heat had to be produced through a $4\frac{1}{2}$-inch fire brick partition, whereas the gases pass directly into the single arched ovens. I have good reason to believe that there are malleable iron makers in this country to-day to whom the single-arched oven is unknown.

THE RAILWAY MASTER MECHANIC

In an editorial commenting on "Specifications for Malleable Iron Castings," thus treats the subject:

The rapid growth of the use of malleable iron castings in car and locomotive construction has been brought about principally through constant and material reductions in their selling cost; the former great difference in cost between grey and malleable iron castings having largely disappeared. There is still an average difference of about one and one-quarter cents per pound between grey and malleable iron, but this difference nearly or quite disappears in the net costs; a malleable casting of a given pattern weighing sometimes sixty per cent less than the corresponding grey iron casting. This great slump in malleable iron prices has benefited the purchasers at the expense of the manufacturers, the larger part of it having come out of the profits of the manufacturers. It is true that increased and improved facilities have cheapened the cost of production, and the stronger companies have been able to buy raw materials at lower prices. But there is a danger now that purchasers will be made to suffer unless they protect themselves by rigid requirements as to quality.

It is admitted by conservative manufacturers that profits have been scaled down so low that but little more can be done in that direction without sacrificing all profit. No further advantage is possible in the purchase of raw materials. The cost of selling is increasing, which is due to competition; wages can go no lower, and there seems but little to be gained in the direction of improved foundry facilities. So the danger hinted at is that advantage will be taken of sacrificing the quality of the material, of turning out carelessly molded and carelessly and insufficiently cleaned and annealed castings. Good malleable castings never

have been and never will be produced as cheaply as grey iron castings. If competition and the demands of purchasers hammer the price down lower than those for which good malleable castings can be produced, purchasers will suffer by receiving material of inferior quality, castings not sufficiently close to patterns and which are insufficiently cleaned. It is obvious that manufacturers must realize some profit in order to remain permanently in business. One way to check the downward tendency of prices and thus save the quality is for purchasers to buy under rigid specifications. And why not? Almost everything else that is bought by a railroad company, in which the purchasing department is watched, is bought under specifications. There would scarcely have been a bottom to prices and perhaps scarcely a bottom to the quality of materials if it had not been for the specifications under which they have for a number of years been bought.

Malleable iron foundries are multiplying rapidly, and while the demand for this material is increasing, the capacity to supply is undoubtedly growing faster than the demand. In the hot competition now existing, purchasers are getting the benefit of constantly lowering prices. This, as has been said, is well enough while it is not accompanied by a deterioration in the quality of the castings. Conscientious founders will maintain the quality and probably fail for the want of profits rather than sacrifice their reputation for good goods. Others may try to save themselves by "skinning" in the quality of their work and their customers may also be subjected to this process. The result of this will be a check to the use of malleable castings. We suggest that much trouble may be saved to both manufacturers and users by working to specifications. This course would fix the bottom prices at which it would be profitable to sell or buy malleable castings.

There is no dispute now that it is profitable to users to pay an additional cent or more per pound for malleable castings than the prices for which the best grey iron castings can be bought. The reasons need not be mentioned here, as they are generally recognized; but unless the quality is maintained there is no advantage in making the substitution.

THE MECHANICAL WORLD.

(Manchester, Eng.)

Joseph Horner, in continuing "Modern Engineering Workshop Practice," treats matters connected with the cupola, from which we condense the following:

The effective height of a cupola to the charging door is an important factor in economical melting. Ireland's cupolas, once so popular, and still in use, were exceptionally tall. The proportions of height to diameter vary. As the diameter increases, the relative height diminishes. The reason why height is an economical factor is that the gases generated by combustion do not pass away imperfectly burned in a tall cupola, but remain long enough in contact with the iron to complete their combustion, and so render up their equivalent heat units.

The primary essential, however, in economical cupola practice lies in the volume and method of the application of the blast. As regards the first there is little difficulty. If the blast delivered is insufficient, it is not because knowledge or data thereon are wanting, but because the matter is neglected by the furnaceman or his employers. It is in the method of application that so much difference exists.

Probably there is no detail of cupola practice about which so many different opinions exist as that of the number and location of tuyeres in a cupola. Excellent results have been claimed for certain arrangements. With these arrangements, doubtless there has been coincident economy. Yet it does not always follow that the good results have been due to the tuyeres. They have been due in some cases to other details, as height of cupola, sufficiency of blast, methods of charging and of fluxing, quality of coke, etc. It is of little use to compare the results obtained by a given cupola with those of another elsewhere, working under a totally different set of conditions. Only when comparative tests are made of cupolas working under precisely similar conditions can the results be of much value.

The aim is, or should be, to diffuse the blast in an equable manner throughout the melting zone or area. The blast is

brought in wholly below the melting zone, and rises diffused into the latter. Iron could not melt directly opposite to these tuyere holes. It melts higher up and drops down into the area beneath the tuyeres, where it accumulates ready for tapping out. It is clear that two tuyeres will not give so diffused a blast as will several tuyeres. Hence, the first advance in this direction is that of a zone of tuyeres, conveying into the cupola from a common wind chest or air belt. The area of each tuyere does not seem to be a matter of much importance, provided the collective tuyere area is equal to that required for the size of cupola, and that the blast enters under sufficient pressure. There is a disadvantage incident to the use of small tuyeres—namely, their increased liability to become choked up with slag. As a set-off against this, there is the fact that the slag is less likely to form in the vicinity of a small volume of cold moving air than in that of a large volume.

The absence of uniformity in the conditions of cupola practice—far more irregular than those of blast-furnace practice—goes far to explain many of the conflicting accounts of diverse results obtained in cupolas of similar types. Methods of charging, qualities of metal and of coke used, the frequency of slagging, and especially the duration of a cast, are all vital matters. Very much depends on the furnaceman, who may get good results from an inferior cupola, or may vitiate the results which ought to accrue from the use of a good one. The matters which conduce to good results are these: The charging of the coke and iron in regular order and in fairly even layers, the breaking of the iron into small pieces, the avoidance of burnt iron, the use of good coke, slagging repeated with sufficient frequency relatively to the kind of metal and fuel in the charge, the use of sufficient limestone to flux the earthy matters, the running of long casts rather than short ones, sufficient volume of blast, and the use of zones of tuyeres and of one or two upper zones, either of smaller area than the lower, or else placed under the control of the furnaceman, so that some may be shut off if the supply of air becomes excessive.

A good deal of the trouble of inferior castings must be sought in the cupola rather than in the mold. If iron is melted badly—dull, cold, thick, contaminated with impurities from the coke or from dirty scrap—the molder's work is thrown away. The furnaceman does not always receive either the blame or the credit due to him, but the molder gets the chief share in either case.